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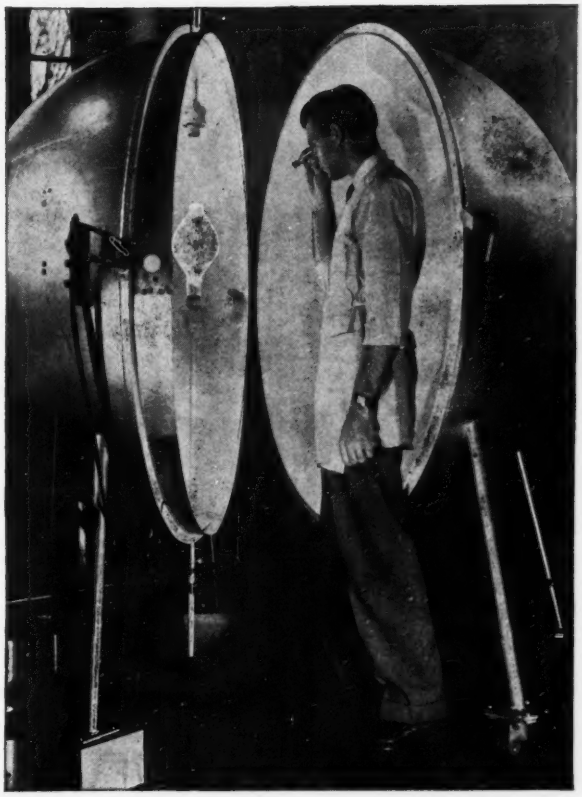

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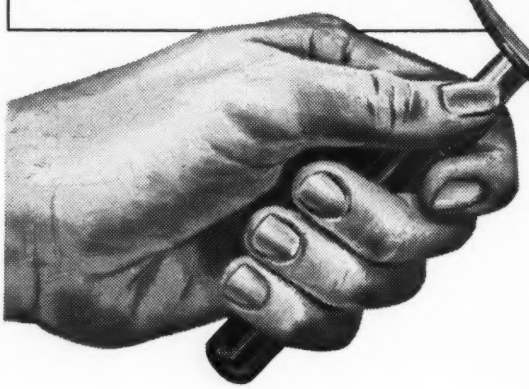

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Volume 15 November, 1949 Number 2

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COVER: A typical fall scene on the Engineering campus shows Walt Bortko, CE '52 at the transit.

W. H. Ferguson

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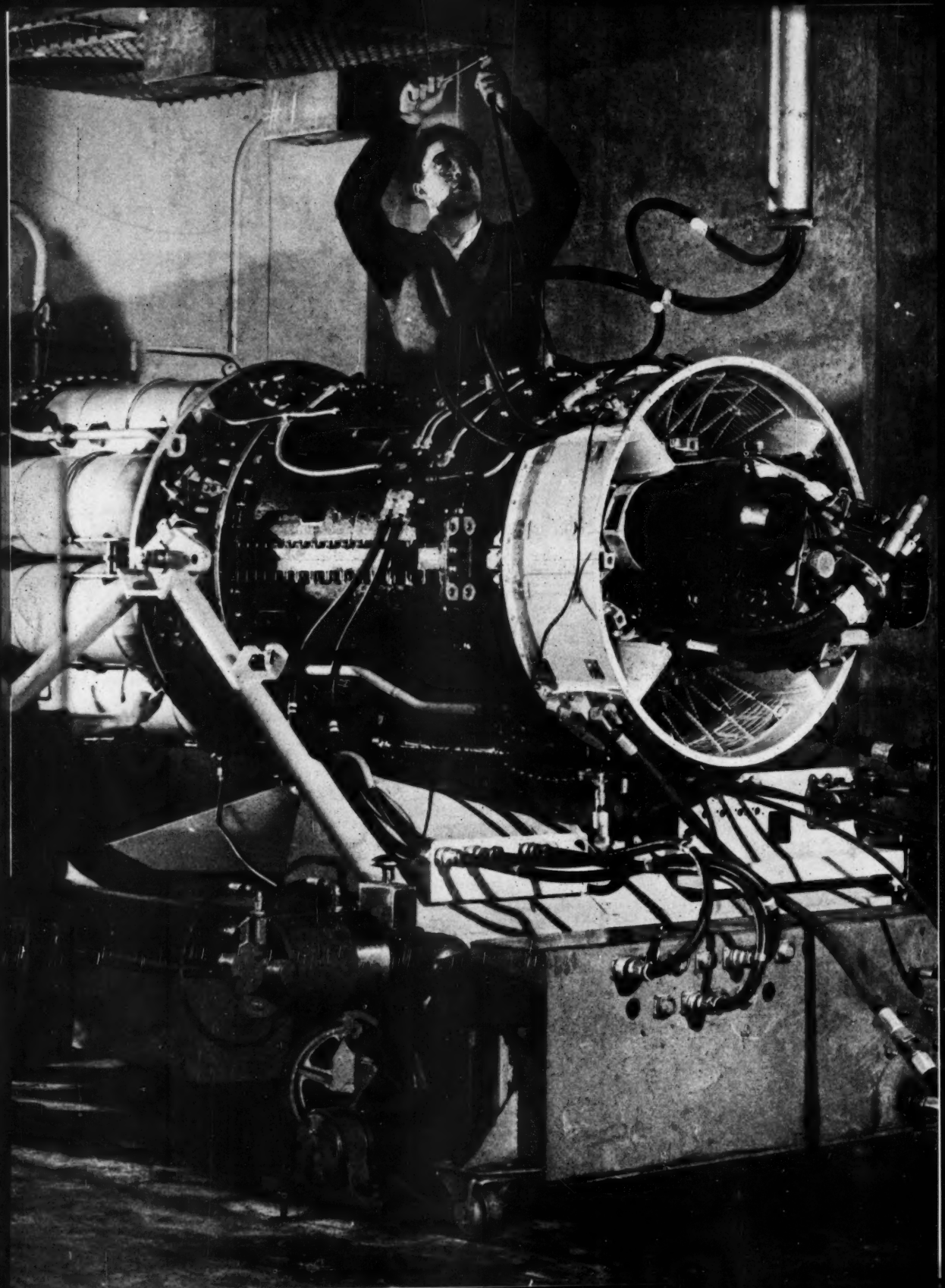
Published monthly—October to May—by the Cornell Engineer, Inc., Lincoln Hall, Ithaca, N. Y. Edited by the undergraduates of the College of Engineering, Cornell University. Entered as second class matter at the Post Office at Ithaca, N. Y., under Section 103, Act of October 3, 1917.

Subscription per year: regular $2.00; with membership in the Cornell Society of Engineers $3.00 (See President's page); student $1.50; single copy $.25.



THE USE OF STAINLESS STEEL

By RICHARD E. PARET, E.E. '40

Photographs courtesy American Iron and Steel Institute

NO metal, alloy of metals, or series of alloys is suitable for every purpose. The search by the alchemist for gold from base metals was no more futile than would be the search for a "universal alloy." There is, however, a series of 27 steel alloys, developed through the art of metallurgy, which are extremely versatile. These alloys are commonly known as the stainless steels. Their analyses, as defined by American Iron and Steel Institute, are shown in Table 1.

Alloying Elements and Properties

These stainless steels possess certain common characteristics, which have led to their widespread application in many fields. They include: corrosion resistance, heat resistance, strength at all temperatures, amenability to fabrication, lasting beauty.

Each of the 27 stainless steel alloys possess these merits to varying degrees, as determined by its composition. For example, increasing amounts of chromium result in increased corrosion and heat resistance. Addition of nickel in quantities of 7 per cent or more in proper balance with other elements makes the alloys non-magnetic, increases workability and weldability, permits retention of a high degree of ductility in high temperature applications, and increases the rate of work-hardening.

Molybdenum in stainless steel increases its resistance to external corrosives and increases strength, toughness and resistance to creep at elevated temperatures. Columbium and titanium are used to protect chromium-nickel steels from intergranular corrosion which might result from exposure to corrosive media after heating into critical temperature ranges.

Other elements are added to certain of these alloys, to improve their machinability; and special alloy balances are used for applications where unusual ductility, extra high workhardening, high hardness or some other physical modification is required.

Use of Special Alloys

Certain other minor modifications of the standard analyses are sometimes made to meet specific job applications. The addition of a stabilizing agent to the molybdenum-bearing austenitic steels, for example, may eventually become an accepted standard type and find its place in the list of recognized alloys. Other special alloys are those containing copper and other elements for specific increased resistance to sulfuric acid; higher alloyed steels for elevated temperature service in jet propulsion engines, gas turbines and such mechanisms. These steels are still minor factors in the tonnage picture, although their importance is growing rapidly.

The production of stainless steels

Readying the powerful J-47 aircraft jet engine for its initial test. Rated at more than 5000 pounds thrust or driving force, this jet is the powerplant of the speed record holder, the North American F-86 fighter.

—*Courtesy General Electric*

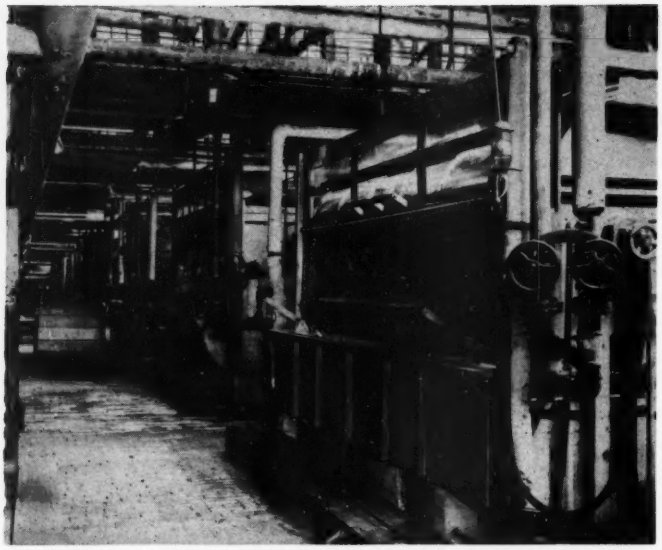
THE AUTHOR

Richard E. Paret, a native New Yorker, attended Cornell University College of Electrical Engineering in the class of '40. In 1939, he decided on metallurgy as a career and went with Crucible Steel Company where he was charged with customers' problems and served on specification and technical committees. In 1944, he became chief engineer and later superintendent of Bergen Precision Castings, Inc.

Mr. Paret became Stainless Steel Specialist of American Iron and Steel Institute in 1947. As a recognized authority on stainless steel, he is consulted daily on commercial and industrial uses of the metal.

Since leaving Cornell, he has studied at Brooklyn Polytechnical Institute, Columbia University and Stevens Institute of Technology. He is a member of Theta Xi and American Society of Metals.

Richard E. Paret



Stainless Steel dye becks require only hot water spray rinsing between cold batches. The non-corrosive metal protects against dye contamination and needs little maintenance.

in the United States represents over 7 per cent of the country's alloy steel production, which in 1948 was 8,472,781 net short tons. These steels are important, in production of chemicals and petroleum products, sanitary mass handling of foods and drugs, improvement of industrial efficiency by increased life and lower maintenance of equipment. The effort spent in developing and promoting the use of stainless steel is therefore high in proportion to the tonnage total.

Production of stainless steel ingots in net short tons is shown in Table 2.

TABLE 2

Growth of Stainless Steel Industry Based on Ingot Production

(Net Short Tons)

Year	*Production*
1929	42,000
1936	114,000
1939	180,000
1942	337,000
1946	543,000
1947	513,000
1948	612,000

Because of superior corrosion resistance, formability and weldability, the chromium-nickel types represent about 70 per cent of stainless steel production. A comparison between the production of chromium-nickel and chromium stainless steels in 1942, (the first year for which such figures are available) and the last three years shows a fairly uniform trend.

TABLE 1

STANDARD TYPE NUMBERS, CHEMICAL COMPOSITION LIMITS AND RANGES

To meet the various requirements for applications of stainless and heat resisting steel, 27 type analyses have been adopted as standards by the Industry, each of which has distinctive characteristics which govern its application and use.
The chemical composition ranges given are based on ladle analysis. Also given are the type numbers which are in use throughout the Industry and which serve as a definite means of identification for the different grade classifications.

	Chemical composition, per cent							
Type Number	C	Mn Max.	Si Max.	P Max.	S Max.	Cr	Ni	Other Elements
301	Over 0.08/0.20	2.00	1.00	0.040	0.030	16.00/18.00	6.00/8.00	—
302	Over 0.08/0.20	2.00	1.00	0.040	0.030	17.00/19.00	8.00/10.00	—
302B	Over 0.08/0.20	2.00	2.00/3.00	0.040	0.030	17.00/19.00	8.00/10.00	—
303	0.15 Max.	2.00	1.00	—	—	17.00/19.00	8.00/10.00	P, S, Se Min. 0.07, Zr, Mo Max. 0.60
304	0.08 Max.	2.00	1.00	0.040	0.030	18.00/20.00	8.00/10.00	—
305	0.12 Max.	2.00	1.00	0.040	0.030	17.00/19.00	10.00/13.00	—
308	0.08 Max.	2.00	1.00	0.040	0.030	19.00/21.00	10.00/12.00	—
309	0.20 Max.	2.00	1.00	0.040	0.030	22.00/24.00	12.00/15.00	—
310	0.25 Max.	2.00	1.50	0.040	0.030	24.00/26.00	19.00/22.00	—
314	0.25 Max.	2.00	1.5/3.0	0.040	0.030	23.00/26.00	19.00/22.00	—
316	0.10 Max.	2.00	1.00	0.040	0.030	16.00/18.00	10.00/14.00	Mo 2.00/3.00
317	0.10 Max.	2.00	1.00	0.040	0.030	18.00/20.00	11.00/14.00	Mo 3.00/4.00
321	0.08 Max.	2.00	1.00	0.040	0.030	17.00/19.00	8.00/11.00	Ti 5xC Min.
347	0.08 Max.	2.00	1.00	0.040	0.030	17.00/19.00	9.00/12.00	Cb 10xC Min.
403	0.15 Max.	1.00	0.50	0.040	0.030	11.50/13.00	—	Turbine Quality
405	0.08 Max.	1.00	1.00	0.040	0.030	11.50/13.00	—	Al 0.10/0.30
410	0.15 Max.	1.00	1.00	0.040	0.030	11.50/13.00	—	—
414	0.15 Max.	1.00	1.00	0.040	0.030	11.50/13.00	1.25/2.50	—
416	0.15 Max.	1.25	1.00	—	—	12.00/14.00	—	P, S, Se Min. 0.07, Zr, Mo Max. 0.60
420	Over 0.15	1.00	1.00	0.040	0.030	12.00/14.00	—	—
430	0.12 Max.	1.00	1.00	0.040	0.030	14.00/18.00	—	—
430F	0.12 Max.	1.25	1.00	—	—	14.00/18.00	—	P, S, Se Min. 0.07, Zr, Mo Max. 0.60
431	0.20 Max.	1.00	1.00	0.040	0.030	15.00/17.00	1.25/2.50	—
440A	0.60/0.75	1.00	1.00	0.040	0.030	16.00/18.00	—	Mo 0.75 Max.
440B	0.75/0.95	1.00	1.00	0.040	0.030	16.00/18.00	—	Mo 0.75 Max.
440C	0.95/1.20	1.00	1.00	0.040	0.030	16.00/18.00	—	Mo 0.75 Max.
446	0.35 Max.	1.50	1.00	0.040	0.030	23.00/27.00	—	N_2 0.25 Max.

TABLE 3

PRODUCTION OF STAINLESS STEEL INGOTS
YEAR, 1948

Type No.	Ingot Production	Type No.	Ingot Production
301	61,520	403	6,311
302	146,595	405	4,127
302B	1,522	406	2,291
303	15,095	410	25,494
304	98,838	414	5,538
308	2,861	416	16,226
309	4,898	420	4,970
310	5,414	430	122,537
316	27,523	430F	1,510
321	7,349	431	1,121
347	31,043	440A	1,431
		440B	218
		440C	1,179
		442	319
		443	10
		446	1,964
All other	9,247	All other	4,605
Total	411,905	Total	199,851
Total All Types			611,756

As reported by 20 companies, which in 1947 represented 98.8% of the total output of stainless steel ingots as reported to American Iron and Steel Institute.

The quantity of production of even the standard grades of stainless steel varies widely. In Table 3 is shown ingot production of the various types of stainless steel in 1948. Figures are net short tons.

Type 302 appears in the list of most popular grades, as it is the general purpose austenitic grade. Type 304, the lower carbon modification, is also widely used for general applications, usually where welding and subsequent corrosive conditions necessitates reducing of possibilities of weld decay. Type 430 is used almost universally for automobile molding and trim and also for kitchen and display moldings. The major portion by far, however, must be assigned to the automobile industry. The position of Type 301 on this list may be due to the increase of its use in architectural applications or as a measure for the conservation of nickel. At any rate its production in 1948 was 2.5 times that in 1947.

One trend not shown in the above figures, and contrary to that in England, is the comparatively small use of the columbium and titanium stabilized chromium nickel stainless steels, as shown in Table 4. Production figures are in net tons; percentages refer to total production of austenitic stainless steels.

It will also be noted from Table 4 that, again contrary to British practice, columbium has become the preferred stabilizing element. Because of the greater supply of titanium and the strategic importance of columbium an investigation should be made into the reasons for preference for columbium and the actual relative merits of the two. Partial reason for the decrease in consumption of these two types lies in the development and commercial production of extra low carbon Type 304 and Type 316 in which carbon is furnished at .03% maximum. Immunity to intergranular corrosion when subject to high temperatures only during processing, not in service, are found with 0.03% carbon steels of Type 304 analysis.

Although much is known about stainless steel there is yet a need for additional investigation of its properties, especially as regards corrosion resistance.

TABLE 4

Production of Ingots of Stabilized Austenitic Stainless Steels

Year	Type 321 (Titanium stab.) Production (Net Tons)	% of total prod. of Cr-Ni steels	Type 347 (Columbium stab) Production (Net Tons)	% of total prod. of Cr-Ni steels
1944	61,641	17.9	26,988	7.8
1945	37,388	9.9	32,364	8.5
1946	3,555	0.9	16,113	4.0
1947	6,949	1.8	31,043	7.5

Stainless Steel entrance to the Architects building.

To determine the shipments of stainless steel products by market classifications, American Iron and Steel Institute compiles data furnished by steel producers. That report not only shows what products are consumed by various industries and groups, but also permits determination of the relative consumption of stainless steel in the various market classifications.

Distribution of Stainless Steel

A large percentage of stainless steel sold in the United States is distributed through jobbers, dealers

(*Continued on page 26*)

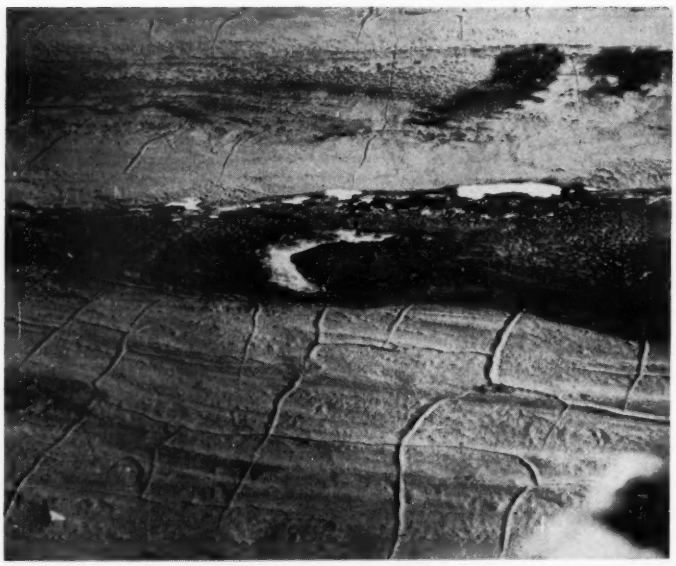
Arctic Engineering

By PROFESSOR TAYLOR D. LEWIS

Photographs courtesy the Author

The Arctic and Sub-Arctic regions present to the engineer a challenge which must be accepted if our present way of life and future plans are to be retained and realized. This challenge to the ingenuity of the engineer is simply a renewal of the defiance of the frontier to change. This defiance takes the form of difficult transportation and unfavorable climatic conditions for more than existence.

The search for Sir John Franklin about one hundred years ago and the more recent Polar dashes were the last events to draw the interest of the world to the Arctic. Now our interest could be classed as much more practical although probably just as spectacular.



Frost furrows forming rectangular pattern as differentiated from polygon pattern.

Why We Develop Arctic

Our reasons for concern with the Arctic and Sub-Arctic are usually grouped into two categories; the first being national defense against aggression from the direction of the North Pole; and the second being our ever-growing quest for new deposits of natural resources. Practice of the policies of conservation would delay, and in some cases, entirely eliminate this need for new supplies of critical natural resources. But our economy seems based on the "lavish hand" or waste in some industries. This economy is usually justified for this generation, with little or no thought of the next. On the other hand, as far as our continent is concerned, some items in demand because of recent technical developments may be found only in this northern area. Therefore, the engineer is called upon to make possible and profitable this procurement of minerals, petroleum, coal, and other wealth.

In our national defense, we are concerned with installations for transportation, communication, living, and working. The locations of these installations may vary slightly to fit the strategy of the terrain. This variation may afford slight flexibility. On the other hand, the installations for the development and exploitation of natural resources are generally inflexibly located, both in space and time which makes the engineering situation more difficult.

Difficulties Encountered

Foundation trouble is the major engineering difficulty encountered in the Arctic. This trouble affects the living and working installations as well as the transportation systems. The identification of the trouble may be condensed into one descriptive term "Perma-frost," and the solution to perma-frost may be said to be aggregate.

Esker in central Canada on bare rock, approximately 70 feet high, 400 feet wide and 35 miles long.

Perma-frost is permanently frozen earth, soil, or rock. It may be either wet (saturated), or dry. The dry perma-frost is below freezing temperature but contains no water therefore is not cemented together by frost. The wet perma-frost contains ice crystals or lenses and is cemented together by frost, in other words frozen solid. The difficulties encountered with perma-frost will depend on two things; first the insulation, and second the particle or grain size of the soil.

Where the ground is fairly level and there is a silt-sized soil, polygons of the ice wedge type will occur as perma-frost manifestations. These polygons will be about 40 feet in diameter and slightly dome-shaped. The borders will contain ice wedges to the same depth as the active zone and anywhere from 2 to 4 feet wide at the surface. These margins are slightly depressed and usually marked by more abundant vegetation. Since they occur on level areas, airports have been frequently built on polygon beds. The polygon margins give no foundation trouble for the air strip during the cold season, but reappear in the failure of the pavement constructed over them, during the thawed season. Pilots may leave a perfect runway in the morning, and return to find failure ditches across the strip that afternoon. Leveling the polygons and filling in the low spots may give a satisfactory winter airport, but it must be remembered that parts of the strip are supported by the ice wedges.

Recognition of Perma-Frost

In areas where the glaciers deposited till (mixture of boulders, gravel, sand, and silt) other types of polygons will appear. These polygon forms are mud boils, stone flowers, stone ring polygons, and stone stripes. These manifestations of perma-frost occur in the Canadian North West Arctic. One may be certain that foundations for roads, air strips, buildings, or other installations would not be satisfactory in areas of these polygons.

Also in this Canadian Arctic region, the ice caps have melted off many of the islands and with this great weight removed, the land has gradually been elevated. This emergence has given the sea a chance to work over the glacial till and remove the fines. Wave and ice action builds ridges or strand lines, which in some cases appear at elevation in excess of 600 feet above present sea level. This veneer of beach gravel makes excellent aggregate and may be characterized both by the contour-like strand lines and frequntly by frost furrows. Frost furrows are not drainage lines, but simply planes of weakness which open up annually as the earth contracts with low temperature. Sea ice has been known to open up leads as much as 14 feet wide in a single night, therefore it is not surprising that the frost furrows in granular soils are eight inches, to a foot wide. In the dead of winter, loud reports or cannonades have been heard by Esquimaux and trappers. It is thought that these loud noises accompany the opening of the frost furrows.

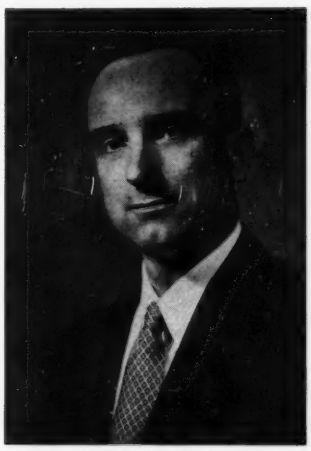
Runway failure showing patches and cracks in polygon pattern, duplicating large pattern in the adjacent areas.

Another manifestation of arctic perma-frost and active thaw zones is solifluction. These may be lobe, sheet, or rill. Rill solifluction simply is the scouring or erosion of small radial gullies, no more than

(Concluded on page 28)

THE AUTHOR

Professor Taylor D. Lewis graduated from the University of Michigan in 1934 with the B.C.E. degree. His major interest has been transportation engineering. In this field he has had wide experience from the municipal, state, army and industrial phases. He did graduate work at Harvard University and came to Cornell from Yale in 1946. Arctic engineering problems have been of particular interest to Professor Lewis since his trip to the Arctic. This trip, and the one during the summer of 1949, are in connection with the research project conducted by the School of Civil Engineering on aerial photo interpretation of land forms and soil patterns.



Taylor D. Lewis

Cornell Society of Engineers

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"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Message

In many countries of the world, there has been a most unfortunate reversal of the pre-war trend toward the encouragement of private enterprise and the development of the individual responsibilities and satisfactions which are its accompaniments. The rise of totalitarianism and the insidious development of paternalism are today stultifying the effort and initiative of individuals in the unfortunate countries so afflicted. It is gratifying to note that within such political structures, there is still a great pride, almost expressed by boasting, of those individuals and organizations which have succeeded in retaining a reasonable degree of independent action. Fortunately, America still remains basically a land of free enterprise and individual opportunity. We must not let it become otherwise!

One of the interesting statements—somewhat smacking of "sour grapes"—made by citizens of these less fortunate countries is to the effect that success can only be obtained in America by very hard work, and position can only be retained by the most strenuous efforts . . . in their opinion, *too* strenuous efforts. I think we can derive great satisfaction from this thought that "success follows effort," and the purpose of this message is to suggest a simple rule, adherence to which will make the work easy.

We are just getting well started on a new 1949-50 season of activity—whether it be in school or in industry. My simple formula for easy success is to hit the prelims and first assignments hard; get a good mark, or do a good job with the first one—and with the second one—and with the third one—and your reputation will be established—and all you will have to do from then on is sit back and take it easy! I know from experience and observation that this rule works.

At this point, I can almost hear the derogatory mutterings of the oldsters saying that such advice is ruination to our youth. But to calm the fears of the oldsters, I would point out that anybody does a good job once—and twice—and three times, only *thinks* he is loafing after that, because he has acquired the habit of doing good jobs. It is almost as easy to develop good habits as bad ones!

And if you don't think this is a good rule, try it in reverse—get a bad reputation and then try and dig your way out !

WILLIAM LITTLEWOOD

Dollars and Production Sense

By HOWARD KALTBAUM, ME '50

Photographs courtesy Westinghouse

The mass production business structure, being subject to the political and economic fluctuations which affect the nation, continuously finds itself in a period of expansion or contraction. The prime concern of the manufacturing engineer is, of course, expansion of the production process. His basic tools are material and labor. Only skillful coordination of these elements results in a smoothly operating plant. In any given situation, "skillful coordination" may connote entirely different methods to different manufacturing engineers. There is no one-school solution to the production problem. Experience, common sense, and the application of the principles of cost control, quality control, and production control, dictate a possible scheme. It may or may not withstand the actual test of operation, but on this plan the company's money, reputation, and time are staked. In such a situation, decisions are carefully weighed and reconsidered on the basis of compiled statistics, and careful analysis of the product.

The Cost Factor

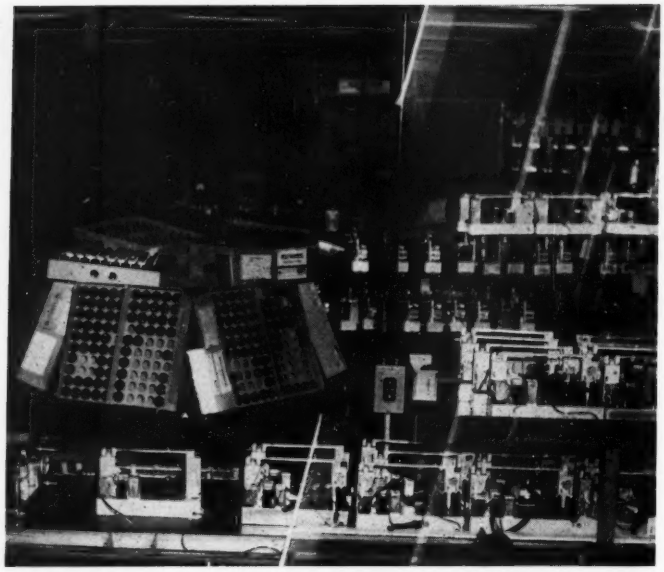
Suppose that you are faced, as you may very well be, with the responsibility of setting up a plan of operations. You are given a manufactured part, or assembly of parts. How can you most efficiently produce the item in quantity? The one factor you must continuously consider is cost. How much? Does it pay? What facilities for production already exist? How many do we expect to sell? With carefully thought out answers to these questions in mind, you proceed to analyze the product from a production point of view.

Examining each part with an understanding of its function in the assembled item, be it an automobile or a wrist watch, a sequence of manufacturing operations is tentatively set down. The maze of possibilities which exist may lead to doubts and uncertainties. Will we produce enough of these parts to warrant the purchase of a special machine tool? A careful financial comparison must be made before the answer to such a question may be found. Cost curves are plotted. The area of increasing returns is determined. Then, other factors are considered. Are the tolerances large enough to substitute a stamped for a machined part? Perhaps even a simplification in the design of the part is a possibility. In such circumstances the design engineer must be consulted. Quite often the simplification may not affect the function but this decision rests with the design engineer.

Use of Special Tools

Having decided whether the part will be cast, forged, welded, or machined from round or bar stock, and having set down the sequence of operations, the major portion of the job is still at hand—a detailed description of tool operations. An intimate knowledge of the shop is an indispensable asset at this stage. Can this part be turned out with existing tools on the automatic screw machine, or are special jigs

Tiering collapsible containers saves space and time. The use of the new containers greatly reduces handling and consequent breakage.



Turntable arrangement for stock of tubes in cartons from which operator can supply radio chassis as it passes on assembly track.

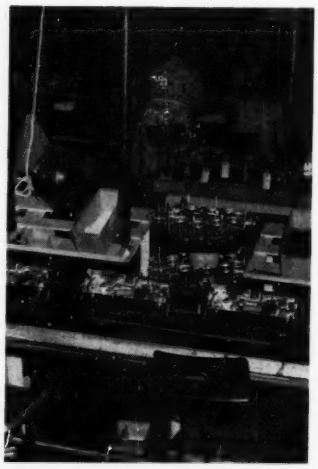
and fixtures necessary? Then again, even if they aren't absolutely necessary, perhaps the quantity of production makes them economically desirable. Assuming you've decided that at a certain point in the manufacturing process a jig is necessary, how elaborate will you permit this tool to be made, so that its usefulness is not completely neutralized by its excessive cost?

You have, then, specified in detail on a set of operation sheets the tools to be used, the order in which they are used, and specifically how they will rough-cut and finally finish cut the work to size. The problem of designing the special tools required is then begun by the tool design department. Here again, cost is the keynote. The ingenuity that enters into the design of a milling fixture or a drill jig is determined not so much by its complexity as by its simplicity. Has the designer combined operations where possible? Has he avoided the use of expensive alloy steels where ordinary low carbon steel will serve the purpose? Special form cutters must similarly show a financial justification for their existence. If this is not the case, a series of cuts using standard cutters may prove to be the solution to such a problem. It must be remembered that these tools are not the direct material of the product, and come under the heading of variable overhead expense. As such, these expenditures will be under the constant scrutiny of the cost department. If a system has been set up in the plant whereby standard costs are used, or if such a system is contemplated, incongruities in the cost of tools will become apparent. No rigid rule may be stated concerning tool expenditures. In each individual case it becomes a question of balancing the almighty dollar against the accuracy and production requirements of the item to be produced.

Let us assume that we have decided to mass produce a new type of safety razor which we have patented. This razor is the result of patient study and modification by the development engineering department. The item then becomes the subject of discussion at a joint meeting of sales, administrative, and technical executives. After the technical men point out the unique features of this razor, the sales department makes an initial periodical sales estimate, based on statistical market reports. Administrative heads must, on the basis of technical and sales reports, and of their own research, decide on how much capital will be risked. The cost of development is added to the cost of production, and a development liquidation card is set up by the cost department. It is then decided how much of the brunt of development costs the initial sales should bear in order to determine a reasonable selling price.

Coordination of Materials and Machines

Production engineering, with a knowledge of how much money, time, and equipment is available for it, then schedules production. The storekeeping department is consulted for available material both on hand and to be purchased. The shops are consulted for floor space, locations, and tools. The materials handling department is consulted for available material handling equipment, such as conveyor belts, electric trucks, fork lifts, and other specialized equipment. Skillful coordination of these elements will result in a smoothly operating production floor. Coordination entails such exacting work as flow charts,



Track and position system applied to radio-chassis assembly.

three-dimensional floor plans, and a progress report on the control board, which, among other information, gives a running account of the actual production as compared to the forecast production.

In the case of the safety razor under consideration, the control board can serve a dual purpose. Primarily, actual sales can be compared with

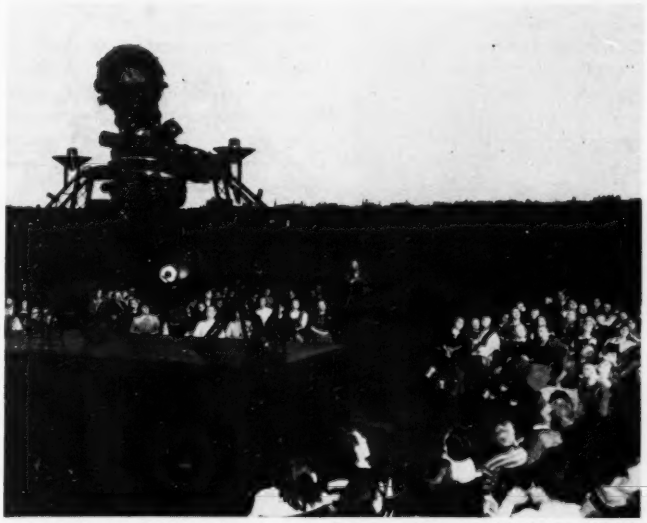
(*Concluded on page* 32)

Seeing Stars . . .

With the Planetarium Instrument

By VICTOR K. PARÉ, EP '51

EVERY afternoon and evening in each of several large cities in this country, a hundred or more people walk into a domed room almost 70 feet in diameter in a scientific museum. Looking around them and wondering at the strange construction of the room, they go in almost complete silence to their seats, which are arranged in circular rows. In the center stands a machine which appears to have been modelled after an imaginative illustration in some science-fiction magazine, and at which the scientific-minded gaze with curiosity and the uninitiated stare with amazement.



A view inside the projection chamber in the Fels Planetarium in Philadelphia. Visible are the lecture station, the "skyline", and the general outlines of the instrument.
—*Courtesy Franklin Institute*

Sky Is Reproduced

When the audience has been seated, an elderly gentleman begins speaking from a platform at the side of the room, explaining that the machine in the center is called the planetarium instrument, and that it will project a replica of a starlit sky on the hemispherical ceiling. As he talks, the room darkens, imperceptibly at first and then more rapidly, until the members of the audience cannot see each other. Although they have been told what to expect, they express their surprise and delight in a chorus of "ohs" and "ahs" when thousands of stars suddenly appear above them, far surpassing the beauty of all but the clearest nights.

Their wonderment grows throughout the hour-long demonstration as they realize that the projected stars above them are in exactly the same relative positions and of the same relative brightnesses as those in the real sky, and that they move in exactly the same manner, at any speed the lecturer chooses. The sky can be shown for any place on the earth, and for any time in the past, present, or future. While most of the stars move in a body, the planets perform their own peculiar gyrations, and the moon goes through its phases in the proper periods.

It is hardly necessary to say that the mechanism for producing these effects is a very interesting one. The instruments of the type were all made by the Zeiss Optical Company of Jena, Germany, between 1925 and 1939. In spite of the fact that their price was around $75,000, 27 of them were installed in cities throughout the world in 14 years. American cities possessing them are Philadelphia, Chicago, Los Angeles, New York, and Pittsburgh.

Mechanism Is Complex

Essentially the planetarium is a large multiple projector, equipped with the necessary mechanical ar-

rangements to provide the proper brightness, motion, and location of the 9,000 heavenly bodies which are visible to the unaided eye, together with some special effects. Its general arrangement can be inferred from the accompanying photographs and schematic diagram. Each of the globes at the ends of the dumbbell assembly is 29 inches in diameter and contains 16 projectors, which provide images of all but a few of the fixed stars. The projectors in a globe are fed by a single 1,000-watt lamp, and each consists of a condensing lens and a tessar-type projection lens, between which is a copper-foil star plate, perforated with many small holes, whose images appear on the dome magnified 80 times, to provide a large group of stars. Brightness of the stars are controlled by the sizes of the perforations in the star plates to give a close approximation to the relative magnitudes of their real counterparts. Sirius is of a brightness which would require too large an image, so that its image is provided by a special projector, and it actually is brighter than the other images, besides being large. Special projectors also show three stars which vary in brightness.

Also the projectors in the dumbbell assembly are aimed so that, if the assembly were at the center of a complete sphere 66 feet in diameter, the stars would appear in their proper relative positions all over the sphere. To adapt the arrangement for actual use it is necessary to orient the projected "sky" with reference to the floor of a room, for any year, time of day, or location on earth. To this end the instrument is provided with motors and gearing which rotate the dumbbell, or projector assembly, about three axes through its center to duplicate the rotation and revolution of the earth, and man's movements on it. The plane of the equator passes through, and can be rotated about the axis 3-3 (on the schematic diagram) to provide for latitude changes; to provide daily motion the assembly is rotated about the axis 1-1, which is perpendicular to the equator of the instrument. Axis 2-2, inclined 23.5 degrees to axis 1-1, provides for annual motion and precession of the earth.

Milky Way Is Provided for

In order to prevent stars from appearing on the floor and on the spectators, the projectors are fitted with weighted "eyelids," which realistically dim and then cut off the image of a star as it falls to the horizon. The "eyelids" are mounted on low-friction pivot assemblies which are in turn weighted and mounted on ball bearing rings which always turn to keep the pivots level, regardless of the position of the instrument. Another interesting part of the machine consists of the two cylindrical projectors which provide the image of the Milky Way. The cylindrical surface of each is a photographic negative, made by photographing a carefully stippled drawing of half the Milky Way. A lamp inside each projector transmits to the dome a very convincing likeness of our wheel-shaped galaxy as seen from the inside.

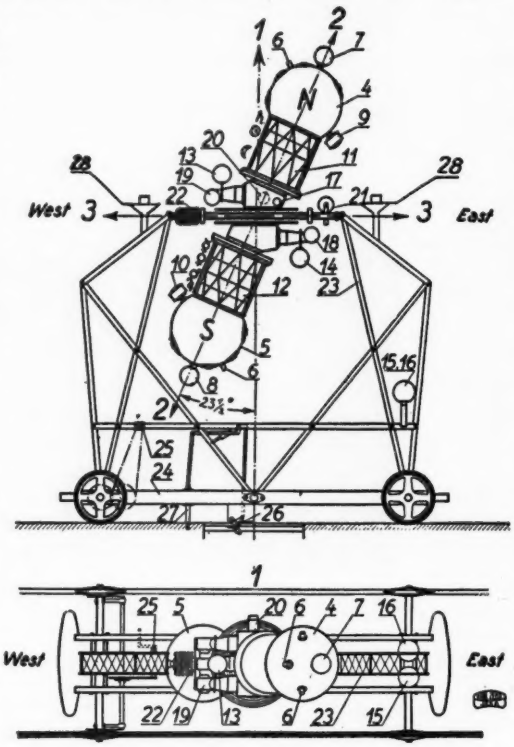


Diagram of the Zeiss Planetarium Instrument in Plan and Elevation

1—1: Polar axis. 2—2: Annual motion and precession axis. 3—3: Latitude change axis. 4,5: Projectors for star fields. 6: Projectors for Magellanic Clouds, Sirius, and typical variable stars. 7,8: Globes carring 30 projectors for constellation names. 9,10: Drum projectors for Milky Way. 11: Cylindrical frame section containing projectors for Saturn, Sun, Moon, Gegenschein, and Zodiacal Light. 12: Projectors for Mercury, Venus, Mars, and Jupiter. 13,14: Globes containing projectors for equator, ecliptic, hour circles, and poles. 15,16: Globes containing projectors for meridian. 17: Projector to designate the year. 18: Two motors for daily motion. 19: Three motors for annual motion (of Sun, Moon, and Planets among the stars). 20: Motor for precessional motion. 21: Latitude change motor. 22: Slip rings to carry current to moving portion of instrument. 23: Fixed frame, of thin steel bars for minimum obstruction. 24: Carriage. 25: Crank and gears to roll instrument along track. 26: Electrical power connection, which can be made only when bolt (27) is lined up with the hole that defines position of instrument in the room. 28: Rheostat-controlled lamps for illuminating chamber.

Special Effects Accounted for

Not so obvious and not often asked about is the equipment which provides for the motions of the Sun, Moon, and planets; yet this is the most complicated and mechanically the most interesting part of the instrument. The mechanisms for producing these effects are located inside the cagelike framework which support

(*Continued on page* 34)

Alumni News

Howard T. Critchlow, C.E. '10, formerly chief engineer of the division of water policy and supply of the New Jersey Department of Conservation, has been named by Governor Alfred E. Driscoll of New Jersey director of this division in the reorganized Department of Conservation and Economic Development. He lives in Trenton, N. J., at 577 Rutherford Avenue and is chairman of the secondary schools committee of the Cornell Club there.

Howard P. Corwith, M.E. '16, has been named vice-president of Western Union Telegraph Co. in charge of development and research. Main offices of the firm are at 60 Hudson Street, New York City.

Karl F. Kellerman, E.E. '29, has been named director of the Washington, D. C., Branch Office of the Brush Development Company of Cleveland, O., manufacturers of

Karl F. Kellerman

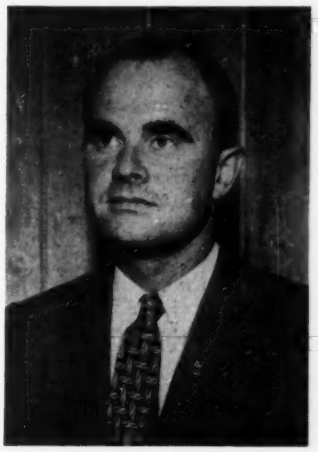
a wide range of electronic and electro-mechanical products. Mr. Kellerman is well known in the electronics industry and in aviation, and has been concerned with many of the current government-sponsored programs of research and development in these and allied fields.

Upon graduation from Cornell, Mr. Kellerman joined the New York Telephone Company to work in communications engineering. He entered the Navy soon after the start of World War II where he rose to the rank of Commander and headed the Electronics Division of the Bureau of Aeronautics. Following the close of the war, Mr. Kellerman returned to private industry to handle engineering sales for Aircraft Radio Corporation of Boonton, N. J.; but at the request of Dr. Vannevar Bush, he returned to government service in June, 1947, to aid in the organization of the new Research and Development Board as the Executive Director of its Committee on Guided Missiles. It is this post which he leaves to join Brush, but he will continue as a special technical consultant to the Research and Development Board.

Mr. Kellerman is a member of Tau Beta Pi, Eta Kappa Nu, the Institute of Radio Engineers, and the Cornell Society of Engineers.

Leslie E. Herbert, M.E. '30, M.M.E. '31, is now civilian chief of the Procurement Planning Branch, Supply and Procurement, Office of Chief, Chemical Corps, located at the Army CML Center, Md. He was formerly chief of the Design Branch, Engineering Division, Technical Command, at the Center. He lives at the Lombardy Apartments in Baltimore, Md.

Thomas M. Ware, M.E. '40, has been appointed chief engineer of International Minerals and Chemical Corporation and assumes full responsibility of the engineering department. Prior to the war he was engaged in armament engineering with the aircraft industry. During the war he was in the United States Navy, Office of Naval Research in the Special Devices Division. Before becoming associated with International he was on the staff of George Fry and Associates, management consulting engineers. His work at International has been as an industrial engineer on the engineering staff.



Thomas M. Ware

William N. Taylor, Chem.E. '44, was recently transferred from the Technical Service Division to the Bayonne N. J., refinery of Esso Standard Oil Co. His address is 426 Vine Street, Elizabeth, New Jersey.

Robert F. Shumaker, C.E. '49, and **William Hershleder, C.E. '49,** have been named winners of the 1949 Charles Lee Crandall Prizes for outstanding papers submitted in the School of Civil Engineering. Mr. Shumaker received the award for his paper, "A Housing Project for $6500 Homes," while Mr. Hershleder earned his award for his paper, "Pile Foundations." The Crandall prizes were established in 1916 and are awarded annually by a faculty committee appointed by the director of the Cornell School of Civil Engineering.

The Editor's COLUMN

Student-Faculty Lounge

Last year considerable publicity was given to the proposed new Student-Faculty Lounge for engineers. To be located in the basement of Sibley Dome, the lounge will provide the engineering campus with a spot where one might have a smoke, listen to some music, and in general, relax between classes and after hours. The lounge also will offer engineering societies a convenient location for meetings. The lack of seating room on the front steps of Sibley between classes is evidence enough to indicate the worthiness of the project, which is being sponsored jointly by Kappa Tau Chi and Atmos.

A survey has shown that a total of $2000 is needed to buy comfortable chairs and otherwise fully equip the room which has been set aside for the lounge. Since the Greater Cornell Fund prevents the initiation of an active drive among alumni for funds, assistance from this group had to be limited to donations of material and equipment.

It became necessary then to secure the financial backing of the faculty and students. Last year a total of only $500 was collected, and therefore it is intended to promote another drive this year, coupled with a concession which Atmos will be controlling during Fall Weekend. It is our hope that this drive will be successfully managed so that the lounge will be opened this year, before the time that many of its contributors may graduate.

It is regrettable that the locations of two of the engineering schools—Chemical Engineering and Engineering Physics—prevent their active participation in this program. However, supporting this project will not only remedy the existing needs of most of the engineers but also will tend to encourage student-faculty relations and help improve the spirit of the school.

PROMINENT

Jim

James W. Hopkins, ChemE

A sense of humor is a distinct advantage for a ChemE who has to fight his way through 710 and a few other "interesting" courses and still retain a decent point of view toward life. Jim Hopkins has maintained this attitude throughout his undergraduate years and has managed to bring a measure of cheer to others of this unfortunate race of Cornellians through his work as editor-in-chief of the Widow.

Working as a cohort of the "little old lady in black", whom the ENGINEER recognizes as having a position of somewhat obscure importance on campus, has been one of Jim's main extra-curricular interests but it has not kept him from participating actively in other organizations of considerably more worth. He came to Cornell in June of 1943 following graduation from high school in Montclair, New Jersey, and, among other things, served as co-manager of the tennis team before being called into the Navy Radio Technicians program.

After two years in the navy, including a hitch in the Philippines, Jim returned to Cornell and began his duty with the Widow. He moved up the ladder rapidly to associate manager and then to editor-in-chief in 1947-48. Other activities include membership in Pros Ops, Aldjebar, Kappa Beta Phi, Quill and Dagger, Tau Beta Pi, and Sigma Chi, where he has held several house offices. He also holds a McMullen Undergraduate Scholarship, which has helped him finance his way through Cornell.

Last summer Jim traveled in Europe under the auspices of the National Students Association, visiting England, France, Scotland, and the Low Countries, and then went hostelling on his own during the last part of his stay abroad.

The major concern following graduation for Jim Hopkins is that of landing a satisfactory job in, he hopes, the administrative end of engineering. The ENGINEER wishes him success in whatever he may undertake and hopes that his keen sense of humor may remain with him throughout it all.

Robert C. Schutt, Jr., EE

Not content to do well in one school in the Engineering College, Bob Schutt is planning to receive degrees in both mechanical and electrical engineering and is well on his way to accomplishing this tour

Bob

ENGINEERS

de force. Bob matriculated in ME in fall, 1946, in the five year program but soon thereafter, due to his status as a veteran, was permitted to transfer to the four-year curriculum. He had reconciled himself to five years of school by that time, however, and found a very satisfactory arrangement whereby he could remain at Cornell for those same five years and get two degrees in the bargain and so, with this in mind, double registered in EE. Ironically, it is the electrical degree that he will receive first, getting it at graduation this spring. The mechanical engineering degree will follow in the spring of 1951.

(*Concluded on page* 36)

Louis N. FitzSimons, CE

Last year saw the first postwar revival of Engineers' Day at Cornell, and, as first president of the newly-formed Engineering Council which initiated and carried through the idea, Neal FitzSimons was one of those most responsible for its success. But Neal has not limited himself to work on the Council, since, in addition to his interests in civil engineering and geology, he has filled other extra-curricular posts in the CE school and elsewhere on the campus.

Neal

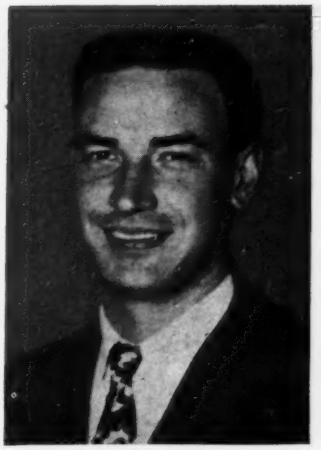
Neal first came to Cornell in July of 1945, after graduating with top scholastic and athletic honors from Storm King School. He was here a bare six months before enlisting in the army, and in that time was one of the few civilians remaining for football practice under Coach Ed McKeever. While in the army, Neal served first as an infantry platoon sergeant and then as a personnel sergeant in the medical corps, and was discharged in May, 1947.

In September 1947, Neal re-entered the School of Civil Engineering. He became interested in the ASCE, and was elected President of the Cornell Student Chapter at the beginning of his Junior year, as well as becoming a member of the CE Honor Committee. Feeling that a greater spirit of unity and more liaison work were needed to bring the various Schools of the College of Engineering closer together, Neal set about early last year to revive the prewar Engineering Council, consisting of representatives from all the Schools. His efforts were rewarding, as evidenced by Engineers' Day, publishing of the Engineering Council Notes, and various other projects, some of which are still under way. By unanimous consent, Neal was elected the Council's first president.

(*Concluded on page* 36)

Joseph M. Carter, ME

Joe Carter claims to be from Boston, but if closely questioned about his accent, confesses to having lived in Virginia some years ago. He left Virginia in 1941 to become an engineer—some years later, in February, 1947, he appeared at the School of Mechanical Engineering to begin his engineering education. In the meantime, it seems his time had been spent in the army and in the engineering department of the Glenn L. Martin Co. of Baltimore, Maryland. After learning the details of aircraft construction for two years, he decided the time had come



Joe

for more engineering education and left his job as draftsman to attend Cornell.

During his three years in the army, Joe spent most of his time in the parachute infantry. He saw most of Europe and finally crossed Germany with the 17th Airborne Division. Then, with things quieting down, he transferred to Military Government and spent a year doing his bit to help put Germany together again. Apparently he still wasn't fed up with the military life, for he joined advanced Air ROTC soon after coming to Cornell, and was one of the first group to be given USAF Reserve commissions at Cornell. He spent the past summer as communications officer with a jet fighter wing on Cape Cod.

Joe's interests now, outside of keeping up with his engineering work, his activities in Tau Beta Pi and other engineering societies, lie mostly in winter sports. After trying for several years to combine skiing with the pistol team, which he captained last year, he decided the two wouldn't mix, so he will concentrate on skiing this winter. He is already deaf to the heckling of non-skiers, and hopes for the most severe winter in history this year. One can't afford to say that too loud, though.

When asked for comments about the engineering schools at Cornell, he had just one comment: "Don't they have *any* classes with girls in them?"

News of the College

Bearing Research

One of the most interesting of the many projects in research being conducted on Cornell's campus is the journal bearing research project now going on in the basement of East Sibley Hall. The photograph shows a view of the new laboratory which is equipped with facilities for testing journal bearings under special conditions. The project was initiated in 1948, sponsored by the National Advisory Committee on Aeronautics.

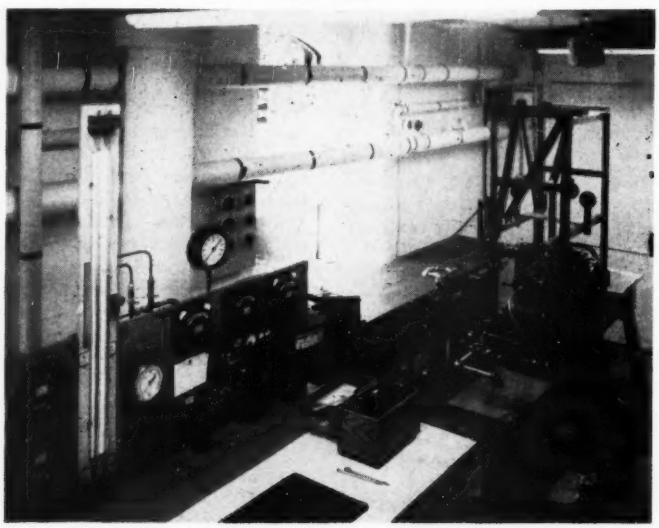
The project is engaged in an experimental investigation of aircraft type pressure-lubricated plain bearings in the field of severe operating conditions that may occur in adverse applications. The investigation is concerned with a study of misalignment by applying known couples rather than given angular displacements. With the bearing operating under load simulating aircraft conditions, couples may be applied which tend to load the bearing more heavily at one end, or which tend to twist the bearing about the axis of the load. A special machine has been designed and constructed which permits the application of small misaligning forces or couples to the test bearing in addition to the large major load of several tons. The design incorporates a method of isolating or floating the single test bearing so that the small frictional and other effects can be measured.

The operation of the machine requires a number of pumps for aircraft lubricating oil as well as for hydraulic loading and torque measuring devices. The present drive system uses aircraft type generators and motors to drive the test shaft directly at a speed which can be varied in a range of 2,000 to 10,000 revolutions per minute. Cooling air for the aircraft units is supplied by two small blowers. One of the happiest results is the low noise level, the machine itself being quieter than the auxiliary equipment. A gear unit is being planned to increase the speed.

Nearly all of the special equipment has been machined in the engineering College Shops from designs prepared in the Department of Machine Design. Several members of the staff of the Engineering College are engaged part time on this project under the supervision of Professor George B. DuBois, director of the project and Dr. Arthur H. Burr, head of the Department of Machine Design. Profesor DuBois was for several years a project engineer on aircraft engines for the Wright Aeronautical Corporation. Professor H. H. Mabie and Professor F. W. Ocvirk are both actively engaged in this project, and in addition aid from specialists in other sections of the Engineering College is obtained from time to time. Accounting, purchasing and similar services are provided by the appropriate divisions of the University.

The work is done under contract with the NACA, the first year ending last spring with the construction and calibration of the machine. A new contract has been received to continue the investigation during the current year.

Research on aircraft-type pressure-lubricated bearings is in progress in this new lab in East Sibley.



Faculty Appointments

The appointment of three associate professors in the School of Civil Engineering has been announced by the College of Engineering.

Paulis P. Bijlaard, who joined the staff last spring, and Arthur J. McNair, who began teaching this fall, become associate professors of civil engineering. Floyd O. Slate is named associate professor of engineering materials, effective this fall.

Bijlaard was graduated from the Institute of Technology at Delft, in his native Holland, in 1920. He was with the department of bridges and structures of state railways in the Netherlands Indies from 1920-28, was professor of structural engineering at the Institute of Technology at Bandoeng, N.E.I., 1928-46, and held the professorship of bridges and structural engineering at Delft the following year. From 1946-48 he was a technical adviser with the International Association

for Bridge and Structural Engineering at Zurich, Switzerland.

McNair took the B.S. in civil engineering at the University of Colorado in 1934, the M.S. in 1935 and the C.E. in 1945. He has been a teaching fellow, instructor and assistant and associate professor at Colorado.

Slate took the B.S., M.S., and Ph.D. degrees at Purdue in 1941, 1942 and 1944, respectively. From 1944-46 he worked as a research chemist on the atomic "Manhattan Project." Recently he has been an assistant professor at Purdue.

Captain Gebhard Joins CE Faculty

Captain John C. Gebhard (C.E.C.), U.S.N., Retired, who supervised the construction of the vast U.S. Naval Training Center at Sampson, N.Y., and other important, high-speed building projects for the Navy during World War 2, has joined the faculty of Cornell University's School of Civil Engineering, Dr. C. W. de Kiewiet, acting president of the university, announced recently.

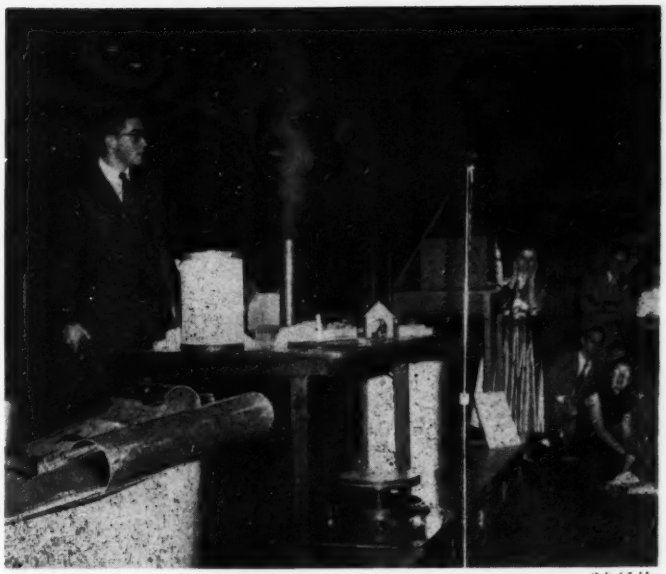
A Cornell graduate of the class of 1919, Captain Gebhard retired this year after a 28-year career in the Navy's Civil Engineer Corps. He has been named an assistant professor of civil engineering at the university.

In addition to the $50,000,000 project at Sampson, which was completed on a six-month schedule, Captain Gebhard directed the wartime construction of airfields, docks and a submarine base in Puerto Rico and a network of airfields for naval air training bases at Pensacola, Fla.

From 1945-47 he was design engineer in the Navy's Bureau of Yards and Docks, and from 1947 until this year he served as public works officer, officer-in-charge of construction and district civil engineer for the 9th Naval District, at Great Lakes, Ill.

A second lieutenant in the Army coast artillery reserve in World War 1, he was with Bethlehem Steel Bridge Corporation before entering the Navy in 1921 with a commission as a lieutenant, junior grade, awarded on the basis of a competitive examination for the Civil Engineer Corps.

At Cornell, where he obtained the civil engineering degree, he won a Feurtes Medal for scholarship and was elected to Rod and Bob, Tau Beta Pi and Scorpion fraternities. He has been awarded the Navy Commendation Ribbon and is a member of the Cornell Society of Engineers, the American Society of Civil Engineers and the Society of American Military Engineers.



—*Critchfield*

Walt Harrison entertains with liquid air at the "Slide Rule Capers."

Slide Rule Capers

Marking another achievement in its effort to further the esprit de corps in the Engineering College, the Cornell Student Engineering Council, presented the "Slide Rule Capers" on Saturday night, October 15. This event was intended to be a revival of the traditional engineers' dances held here in the 'Thirties.

Enticed into the Willard Straight Memorial Room by the offer to "See the Music You Dance To", almost two hundred couples had their curiosity satisfied by seeing the music of Roy Parkins' Orchestra projected on an oscilloscope. Virility was tested by the electrical engineers' kiss-o-meter, which went through all sorts of weird contortions whenever a girl was kissed in its vicinity.

Entertainment during the intermission was provided by Bill Diefenbach, Chad Graham, and Tom Blohm, with Walt Harrison giving a demonstration of "Fun with Physics", showing some of the more spectacular aspects of physics.

The dance served as a follow-up to last spring's successful Engineers' Day, and it, likewise, is expected to become an annual campus event.

Professor Rogers Dies

Fred Stillman Rogers, M.E. '13, professor of machine design in the school of Mechanical Engineering and a member of the faculty for 35 years, died in the Tompkins County, Memorial Hospital on October 2. He was 62.

After receiving his M.E. degree in 1913, he was appointed instructor in 1914, assistant professor in 1918, and in 1924, professor. He was co-author with Prof. C. D. Albert of "Kinematics of Machinery."

Professor Rogers received his B.S. degree magna cum laude from Alfred University in 1909 and worked several years before coming to Cornell to receive his engineering degree.

He was a member of the American Society of Mechanical Engineers and the American Society for Engineering Education.

Recent Developments
In Engineering

Techni-Briefs

Glass Propellors

Helicopter blades are getting a "new look." Blades fashioned from molded fiberglas have recently been flight tested with success. These blades, which have proved both aerodynamically and structurally superior to some conventional types, were developed for the Air Force Materiel Command by the Cornell Aeronautical Laboratory at Buffalo, N. Y. Tests conducted by AMC's Propellor Laboratory have shown that the fiberglas blades will lift more weight for the same horsepower under certain conditions of operation than the best blades of similar size thus far investigated. This increase in lift can be utilized to step up the useful load the helicopter can carry, either in added passengers, cargo, or fuel.

Etching With Atoms

A new etching process to prepare metal surfaces for microscopic examination and photography has been developed by the Ford Motor Company. The unique metal-etching method, never before used in industry, utilizes ionized atoms, and is known as cathodic vacuum etching.

Etching is widely used in industry to examine metal structures for determining quality and aiding in development of new materials or manufacturing processes. Cathodic vacuum etching has brought an important improvement. It enables the taking of an unusually clear photograph of flow-lines, a curious strata-like pattern which indicates the direction the metal flowed when forged under high pressure.

In the new etching technique, the metal sample is placed in a partial vacuum with argon. Twelve thousand volts are charged into the

Examination of metal structure by a new process called cathodic vacuum etching is illustrated above.

vacuum, creating argon ions which bombard the metal surface and knock off minute particles. Under the newly developed method the physical features of metal can be examined under a microscope and measured accurately as to their effect on strength and performance wherever the metal is used. Flow lines in steel samples previously undetected now have been revealed by cathodic bombardment. Comparison of the structure pattern produced by the best chemical etching method revealed that the new cathodic treatment brings out the true microstructure of the metal with greater detail and clarity.

Color Television

A new all-electronic, high-definition color television system, completely compatible with the present system of black-an-white television, has been announced by RCA. The new color television system requires no changes in transmission standards of present black-and-white television. Its performance is equivalent to the present black-and-white service, both for color and reproduction of the color signals in black-and-white. Through its complete compatibility, the new system enables present television sets to receive color programs in monochrome without any modification whatever and without any converter or adapter. Color programs can be viewed either on new color receivers or on existing receivers equipped with a color adapter.

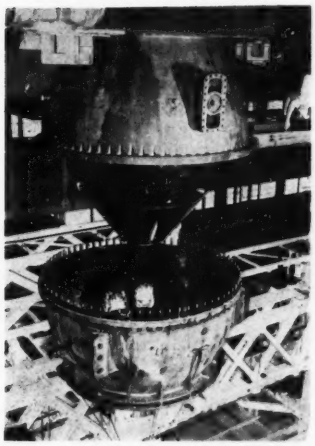
When a television transmitter shifts from black-and-white transmission to color transmission on this system, the viewer of an existing black-and-white receiver will be unaware of the shift. On the other hand, by means of this new system, a viewer of a color set receiving programs in color will, when the station changes from color to black-and-white transmission, see black-and-white pictures without making any changes in his receiver. Thus the transmitting station can change at will, either from color to black-and-white or the reverse, without disturbing the viewers of either the existing receivers or color receivers, without requiring adjustments to either type of receiver and, therefore, without any loss of audience.

Powerful Magnet

Two new permanent magnet materials have been developed by General Electric Company. One of them is GE Alnico 5 DG, a modification of Alnico 5, in which the crystal structure of the magnet is aligned in the direction of magnetization, the letters DG signifying directional grain. Manufacturers who use permanent magnets may now use smaller magnets to do the same jobs as larger magnets for-

merly did. The other material, Alnico 7, has been developed specifically for applications where a high demagnetization force is present, such as in motors, generators, and variable air gap devices. This new magnet shows a higher coercive force than any other grade of Alnico.

Giant Needle Valve



This needle valve is not as small as its name implies. Planned for use in the Friant Dam near Fresno, California, it will pass almost 1,000,000 gallons per minute. Assembled it will weigh 120,000 pounds, the needle alone contributing 20,000 pounds to this total.

—Courtesy Westinghouse

Metals Comparator

More extensive application and wider utility for inspecting and classifying metal parts is provided by a new test head for the General Electric Metals Comparator. The new head was developed for use on specimens such as forgings, machine-tool beds, and other parts which cannot be inserted into the conventional test coil.

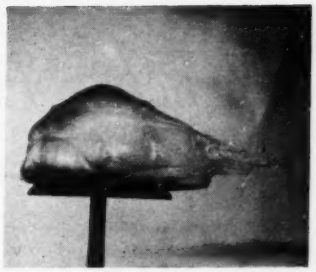
The contact face of the new head consists of a ring, separated by an air gap from a center core, forming a radial magnetic path across which the piece being tested is placed. The contact face can be supplied in vaious diameters, depending on the application. The head is three inches long.

By comparing ferrous and nonferrous parts with a known standard, the metals comparator provides a quick, non-destructive test of the quality of the parts. It enables an operator to maintain close control of such characteristics as composition, heat treatment, or hardness. Besides being a quality tester, the instrument provides an economical means of decreasing scrap losses due to mixed material of incorrect processing. It has been used successfully in the automotive, aircraft, electrical, refrigeration, machine-tool, and die industries.

Microsecond Pictures

The magazine *Sports Afield* recently asked ballistic experts to make comparisons of the various loads of shot used in deer hunting. In their investigations, the ballisticians used the General Electric photolight, which can be used to take pictures with only two microseconds exposure, and with a corresponding definition of motion which can be observed with exposures of such short duration.

In the test set-up, a gun was aimed at a gelatin block whose density was very nearly that of animal tissue. As the projectile from the gun passed over a photoelectric cell, it flashed the photolight and illuminated the test arrangement for the camera to picture the projectile and the block at the instant of maximum impact.



Splat!

New Flame-retardant

Discovery and development of a durable flame-retardant chemical for cotton and rayon, which does not change the appearance or feel of those materials, has been announced by the Du Pont Company. The treatment is durable to dry-cleaning, normal home laundering, and weathering. Properly applied, the chemical has no effect on the draping qualities, appearance, "feel" or strength of the materials. It is the combination of these factors which marks this new product as an improvement.

The metals comparator below compares parts with known standards to determine quality.

Cornell's Honorary and Professional

Freshman, sophomore, junior, senior, and fifth year engineers!

Everyone is past the rush and scurry of those first two months of the school year; the first round of prelims are over; and, at last, a brief breathing spell is in order. Every student engineer should not only be familiar with the professional, honorary, and social societies within his respective school, but should be striving to attain their ranks from his freshman terms onward.

The Cornell Engineer presents the following brief resumes of the various societies within the Engineering College to better acquaint the undergraduates with the eligibility requirements, purposes, current officers, and future plans for each of the societies.

Tau Beta Pi

The national honorary society for engineering students who have exhibited outstanding scholarship coupled with extra-curricular interest and activity is Tau Beta Pi. It was founded in 1885 and has 48,000 members in the nation. The New York Delta was formed at Cornell in 1910. Seniors in upper fifth of their class and Juniors in the upper eighth of their class are eligible for the semi-annual elections.

Tau Beta Pi will continue the tutoring service it organized last year in freshman chemistry, physics, and calculus. Also slated to be of help to freshmen will be the slide rule class the society will conduct during the first week of classes.

This year the officers are Tom Elder, president; Howard Kaltbaum, vice-president; Joe Carter, treasurer; Eugene Jacobs, corresponding secretary; Dave Morgan, recording secretary; Bob Rustay, cataloger.

Chi Epsilon

This national honorary civil engineering society develops character and ability among engineers by recognizing those characteristics which are fundamental to success. After a student has completed half of his schooling, he is eligible for membership; he must be in the upper third of his class and be elected by a two-thirds vote of the active members.

Heading the society this year will be Paul Nichols, president; Dave Morgan, vice-president; Charles Veakyne, secretary-treasurer; Bob Gilfillan, assistant editor of *The Transit*.

Eta Kappa Nu

Eta Kappa Nu was founded at the University of Illinois in 1904 as an honorary society for electrical engineers. Its purpose is to assist its members throughout their lives in becoming better citizens and better men in their profession. Each year the society awards a citation to the outstanding young man in electrical engineering. To be eligible for Eta Kappa Nu, a student must be in the upper quarter of his junior or senior class.

The honorary maintains an award for scholastic achievement for electrical engineers in their sophomore year, and holds frequent discussion groups among the students and faculty on current topics outside of engineering.

Leading the group this year will be Bob Watson, president; John Barnes, vice-president; Robert Rustay, corresponding secretary; Bernard Leibowitz, recording secretary; Raymond Rissler, treasurer. The new chapter adviser will be Professor Joseph Tarboux.

Atmos

This honorary engineering society primarily attempts to forward the interests of the Sibley School of Mechanical Engineering. Athletic events are sponsored; and parties promote faculty-student relationships. Any student, not on probation, and in his junior or senior year is eligible for membership.

Present officers of the organization are Fred Hoerle, president; John Craig, vice-president; William Behr, secretary; George Fitzgerald, treasurer.

American Institute Of Electrical Engineers

The Cornell branch of the A.I.E.E. presents topics of interest to electrical engineers and gives members of the student body the opportunity to participate in activities which are not included in the engineering curriculum. About a dozen meetings are being planned for the year, at which speakers on various topics will be presented.

After the Institute's consolidation with the Institute of Radio Engineers, the elected officers for the coming year were Emery Boose, president; Robert Burns, vice-

Student Engineering Societies

president; Don Thompson, secretary for the I.R.E.; Richard Brundage, secretary for the A.I.E.E.; Albert Bishop, treasurer.

Pi Omicron

In 1946, Pi Omicron, was founded at Syracuse as a national honorary society for women engineers. One month later, the Beta Chapter was founded at Cornell. Its purpose is for the advancement of engineering education among women and to initiate and coordinate activities of undergraduate women. This year it has helped to orient freshman women engineers.

The society's officers this year are to be Marjorie Leigh, president; Leonilda Altman, secretary-treasurer.

Cornell Society of Engineering Physics

The newest engineering society at Cornell, founded a little over two years ago, is the Cornell Society of Engineering Physics. It was formed to foster and to promote fellowship among students, faculty, and alumni of engineering physics at Cornell, and to provide a means of group action and expression for the students in engineering physics. All engineering physics students are eligible to attend meetings, and to become members.

Officers of the society for the year are Victor Paré, president; Meredith Gourdine, vice-president; John Cromack, secretary; Murray Miles, treasurer.

Kappa Tau Chi

Kappa Tau Chi has several aims, chief among which are to promote faculty-student relations and to make contributions toward the solution of faculty-student problems which affect students participating in the affairs of the Mechanical Engineering College.

In furtherance of this aim, this administrative engineering honorary conducts a course questionnaire at the end of each term. This is designed to help the instructors take note of student opinion regarding their courses, and to alter them accordingly. The society maintains a plaque in the engineering library on which is engraved the name of the mechanical engineer most outstanding on completion of four terms of work.

This year's officers are Bill Gere, president; Loren Kahle, vice-president-treasurer; Jim Meyler, secretary.

American Society Of Mechanical Engineers

The principle objectives of the Student Branch of the A.S.M.E. are: 1) to braden the student's acquaintance with the practical side of the practice of Mechanical Engineering, 2) to develop the student's initiative and ability to speak in public and to familiarize him with the parliamentary procedure and organization of learned societies, 3) to enable the student to establish fraternal contact with his fellow students in engineering, and to meet graduate engineers engaged in the active practice of mechanical engineering.

Any student registered as a regular student in mechanical engineering or majoring in mechanical engineering leading to a degree is eligible for student membership.

The officers of the Cornell Branch for the fall term are Bill Kingston, president; Joe Carter, vice-president; Ed Zajac, secretary-treasurer; George Russell and Walt Crone, program chairmen.

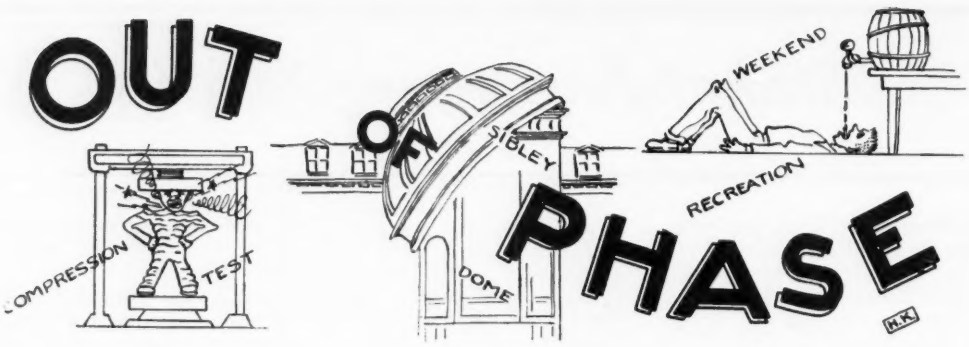
Pi Tau Sigma

Pi Tau Sigma gives recognition to mechanical engineers who have shown their ability by a high scholastic record and participation in extra-curricular activities. Faculty-student cooperation is also fostered. Second term Juniors who are in the upper quarter of the class and Seniors in the upper half of their class are eligible for membership.

This society is at present working on plans for obtaining speakers to prepare mechanical engineers more fully for the professional engineer licensing exam. One of their main activities last year was, with Kappa Tau Chi, the conduction of a drive to raise money for an engineers' lounge. The work proved to be successful, and the lounge will probably be established some time this year.

Officers for the coming year are Dave Kennedy, president; Spencer Robinson, vice-president; Robert Mill, recording secretary; David Purdy, corresponding secretary; John Laibe, treasurer; Robert Allen, social chairman.

(*Continued on page* 38)



HERBERT F. SPIRER, EP '51

Our lean and gangling English professor, Farnwhostle Y. Verbfliesch, was perched on the windowsill in his customary relaxed classroom teaching position. The handful of acorns he secreted in the pouches in his cheeks were unusually agitated. Leaning forward, I soon realized why. He was talking. Anxious to glean every possible gem of information from the English courses which the College of Engineering has so graciously allowed us to include in our sparse curriculum, I listened.

"Gentlemen," he said, "Or should I say, engineers, for weeks now you have been telling me you know how to read. In good faith, I have been taking your word. Assuming that you knew how to read, I have been assigning to you interesting subjects for themes. Your most recent assignment, "Psychological motives for the use of Derived Metaphors in Diametric Secondary Sources" seems to have been too much for you.

"We are going back to fundamentals. You will each be assigned a book to read and report on. For instance, you, Sitzfliesch," he said, waving his quill pen excitedly and frothing in my direction, "You will read the Australian sociological novel, *The Sex Life of the Cathode Follower,* by E. W. Yetter."

Disconsolately I returned to the temporary foot locker in which I have been living since 1946. I told my friends about my assignment, and their faces fell. Picking up his face, my best friend said:

"Do you know what that means? You will have to get that book out of Cornell Library. Can't you drop that course? Wouldn't you rather transfer to Ag? Doesn't your father have a business you can take over?"

"Ha!", I laughed, "What could be so terrible about going to the library? An ordinary, pleasant, house-broken little library? Did a librarian ever bite? Are the fumes fom old books poisonous? Do card catalogs leap out of dark corners onto unsuspecting engineers, strangling the last bit of life out of the victim with grasping index cards? Ha!"

I Had My Chance!

Looking back on it, I must admit that my friends tried to save me. First they told stories to discourage, absurd little tales of students dropping of exhaustion and hunger in the libe and the body being lugged in great secrecy by members of the libe staff to the Stewart Avenue bridge, and faked suicide notes. They told me of an EE, driven to desperation while trying to draw a copy of the Boy Scout Manual falling on his Parker 51 (unsheathed) in the best tradition of Franklin. They warned me, telling of the anxious chemical engineer who rushed into the stacks in 1886 and was found in 1942, pressed into a copy of the US Pharmacopeia, preserved like an old four leaf clover.

They saw that I was determined to go, but still did not give up their attempt to ease my coming trial. They insisted that I carry a knapsack full with food enough for six weeks, swizzle sticks and sleeping bags, walkie-talkie for emergency communication, razors, and liniment for sore feet.

"Ha!", I laughed at them, "What is a trip to a library? You go in, walk to the desk, ask for a book, in two minutes the book arrives, you sign for it and wander out. Hmph! Carry a lunch. Foolishness. It shouldn't take me longer than ten minutes (at the most) to get my copy of *The Sex Life of the Cathode Follower.*"

A few minutes later, slide rule in my teeth, I clambered up the muddy slopes and entered the library. I walked through grand inspiring portals past the women's room, past the men's room, past the reference room, into the main reading room. At first I saw nothing, and received the impression of being in a huge dark cavern. Then, as my eyes gradually grew accustomed to the darkness, what a spectacle! Hundreds of students working away. Engineers, Art Students, Aggies, even Architects, male and female, sat everywhere in form-fit wicker chairs. The long desks on which they worked were truly inspiring. These were no smooth firm impersonal table tops. Not in Cornell's Library. Generations of students have hacked away at the high grade driftwood that had gone into

the construction of these desks, and today the desks are paragons of bas-relief carving, frightening examples of the termite warfare against man, and as easy to write on as a gravel roof.

Just Another Cog

But the eager students hardly noticed. So eager and intent were they upon their studies, that no sound but the roar of the squeaking of hundreds of rheumatic chairs and the scratching of hundreds of pens could be heard. I moved forward toward the main desk, unnoticed, just another cog in the great gears whose endless churning makes Cornell famous.

A female librarian was perched on a high stool behind the counter, daintily paring her nails with a pair of tin snips. Like a perfect gentleman, I moved towards the counter, and said:

"Podden me, madame, but I should like perchance to get a boo—"

"Quiet bud, can't you see that I am busy," she snapped, flipping a sharp segment of fingernail dangerously close to my head. "Now you just wait a minute."

I waited a minute. "Hmph," said I.

She replied with a disdainful silence.

After two hours, my back began to ache. My feet were flattening. I leaned against the counter for support.

"Get the hell off there, you . . . you . . . you undergraduate!" shouted the dainty female librarian in a raucous voice. "Why if I weren't so busy I would have you reported to the head librarian. What are you doing in here anyway, you look old enough to get a job—"

"Well, I should really like to take out a book," I pleaded, cap in hand, "Would you please take this little old call card and see if you can get it?"

She didn't seem to be listening to me. Her body was shaken with laughter. Hysterically giggling, tears running down her pale green cheeks. "Ack-Ack," she cried, calling to an assistant who was busily thrusting burning sticks under the fingernails of some students who had returned reserved books thirty seconds late, "Ack-Ack, look at this character—he wants a book and he wants me to get it. What does he think we are here for? Shall I have the little slob thrown out?"

We Got A System

Ack-Ack inquisitively kicked me in the stomach. "Nawh, let the runt stay here a few days until he gets used to the system. He'll soon find out that this is no ordinary library. We got a system here. It may not help us to find books, but we got a system."

"Now to give you some idea of what our system means, look over there at that group of stack boys, who are supposed to search for the books you call for . . . "

I looked, and saw in a corner of the library, a group of sordid undergraduates, some sleeping on the floor, others, studying comic books, some playing dice, and the rest playing poker and keeping score on the flyleafs of first editions.

"I know what you are thinking," said Ack-Ack, throwing a handful of recent call cards onto the floor, "You are thinking that they are inefficient, lazy and don't know anything about the location of the stacks. You are right. It is just another noble facet of our system. If they were any less inefficient or lazy, people would begin to find out that only about twenty books are in their proper positions anyway. Now what did you say brings you in here? Drink of water? Scratch paper? Or did you just want to make small talk?"

"Well, sir," I bashfully admitted, "I really came here to get a book, *"The Sex Life of the Cath—"*

"Stop! Go no further in this madness." Ack-Ack reached over the counter grabbed me by the collar and drew my face close to his. Talking out of one side of his mouth, and assuming the low desperate tone usually affected by the bookies at Aurora and State, he confided, "Look, buddy, I could take your call card and pass it on to the stack boys . . . but you know what will happen. They will wander around the stacks a couple hours, reading comic books, or maybe giving the once over to the last chapter of Ulysses, go out for lunch, and then send the card back marked, "Out on Reserve." Or so maybe you get a conscientious guy, he starts out meaning to look for your book. But he sees that it is on the fifth floor, so he takes a catnap in the locked press and brings your card back marked *Book Lost*. You don't stand a chance of getting anything but hunger pains. Why don't you do it right, and just walk into the stacks and hunt for it yourself?"

"B-b-b-but what about that?" I asked pointing to the sign over the stack entrance . . . "Positively

(*Continued on page* 30)

"Dean Allen warned us about these engineers . . ."

Stainless Steel

(*Continued from page 7*)

and distributors. Study of data shows that most of this, over 50 per cent in 1948, is in the form of cold rolled sheets. Distribution of the major portion of the remaining shipments which can be called "traceable" stainless steel is shown in Table 5.

TABLE 5

Shipments in Market Classifications Other Than Jobbers
In % of Traced Shipments Other Than to Jobbers

	1946	1947	1948
Automotive	23.6	22.7	27.2
Appliances, utensils, cutlery	22.7	19.6	23.2
Machinery, industrial-equip., tools	15.9	15.3	13.5
Export	6.3	14.4	6.4
Rail transportation	5.4	2.7	5.2
Other domestic & Commercial equip.	9.2	5.3	4.2
Containers	4.8	8.4	3.7
Contractors' products	4.7	3.1	3.6
Aircraft	1.9	2.6	3.3
Electrical machinery & equip.	2.8	3.6	2.7

Study of Table 5 shows considerable constancy in relative consumption on the part of the various market groups. In each of the three past years the Automotive, Appliance-Utensil-Cutlery, and Machinery-Industrial-Tools groups have occupied the first three places respectively. While there is some variation among the others, notably the high percentage of stainless steel exported and used in containers in 1947 and the low relative consumption by the railroads in the same year, the groups are fairly stable. Two trends are noted but may be subject to further study. These are the decrease in relative consumption by the miscellaneous domestic and commercial equipment group (restaurant, soda fountain, domestic and office furniture, sporting goods, professional and scientific equipment and so on), and the increase in relative consumption by the aircraft industry. Both may be temporary trends.

The first downward trend is undoubtedly due to tapering off in postwar building, modernization and re-equipping. The increase in aircraft consumption is probably due to production of large planes for high altitude flying, which require heating and other special equipment of stainless steel.

It was noted that over 50 per cent of the shipments to jobbers was in the form of cold rolled sheet. But the greatest shipments to all consumers are in the form of cold rolled strip (under 24 inches in width). Cold rolled strip represents over one-third of the *total* shipments in 1947 and 1948 and just under one-third the total shipments in 1946.

Figures from several market classications for the first 10 months of 1948 show that the food industry, including processing, meat packing, dairying, restaurant, kitchens and so on, consumed some 41,377 net tons or 27.2 per cent of the traceable stainless steel. As previously noted, a sizable portion of the stainless steel shipped to jobbers undoubtedly goes into this field also. Assuming that very little of the jobbers' stainless steel goes into the automotive industry, the food industry may be considered the major consumer of stainless steel in the United States.

The data presented above indicate that the utilization of stainless steel in a number of industries has become an established practice in the United States. The increased consumption is therefore due to older and experimental uses becoming universal and new uses being developed in industries already familiar with stainless steel. Extensive market development work on the part of stainless steel producers will undoubtedly open new markets.

A consideration of principal applications of stainless steels in the consuming industries might be worthwhile. The food processing industry, of course, uses stainless steel for applications from meat hooks and cutlery to room sized refrigerators and dehydrating equipment, because of the materials' corrosion resistance and easy maintenance. Some health regulations, in the dairy industry, for example, require frequent dismantling and steriliz-

(*Concluded on page 30*)

Rear view of Gas Turbine Jet Engine, shows Stainless Steel tailpipe and combustion chambers.

Let's get down to earth . . .

IMAGINE stealing three billion tons of earth every year! That's what soil erosion has been doing. And this gigantic theft has cost farmers billions of dollars. For good earth is *not* dirt cheap.

"Stop erosion!" has become the farmers' war cry. Agricultural agencies have joined the farmers. Together, they have turned to the farm machinery makers. They've asked for bigger and better bulldozers, tractors, graders for necessary ditching and terracing. But to build this super farm machinery takes tougher steel, *new alloys.*

Here is where UCC enters the allied offensive against erosion. Drawing on its vast engineering experience, UCC contributes modern metallurgical techniques and alloys. This co-operation with steel manufacturers helps the farm machinery makers . . . who then are able to give the farmers the equipment they need.

How is the "war" going? The farmers are winning. Dust bowls are vanishing. Sterile lands show signs of life. Yes, the farmers are winning their fight against soil erosion with a combination of new equipment, revegetation and crop rotation.

Union Carbide is proud of its part in this effort. And the people of UCC stand ready to help solve other problems . . . wherever better materials and processes are needed.

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Arctic Engineering

(*Continued from page 9*)

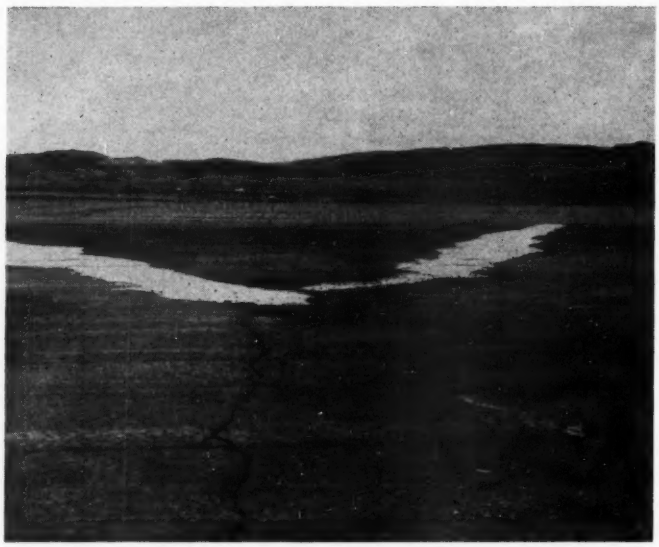
an inch or two wide, down through the shallow soil to bed rock on a height. This occurs when the sun melts the soil water mixture on hill and mountain tops, thus freeing water for scouring the "rill" as it descends. Small quantities of water and soil are involved, thus the rill is of little interest to the engineer, except as a curiosity.

Sheet solifluction and lobe solifluction occur when sufficient water melts at or in the surface soil layer so that the lower slopes slide. The active zone slides on the water lubricated surface of the permanently frozen soil. Sheet solifluction covers larger areas, while lobes usually are under 100 feet in width. The reason the engineer is interested is so that installation will not be located in paths of sheet solifluction or among lobes.

Mention has been made of drainage. Small drainage ditches conduct water which helps melt more permafrost, which erodes and removes the insulation from more permafrost, which provides more water, etc. In fact, the gold-mining industry melts the perma-frost glacial gravels down to bed-rock by pumping water into the ground. Therefore, it follows that the engineer who wants to preserve the permafrost under his road, air strip or building, will do his best to keep water from destroying this permafrost sub-foundation.

In all the problems of permafrost, the generous use of aggregates will lead to the proper solution. The source of these aggregates in the Arctic are easily identied by the use of air-photos. A few of the major sources are briefly discussed as follows:

Beach gravels — identified by strand lines, thick deposits of granular materials characterized by frost furrows. Reworked glacial till may be thin veneer. These gravels may be scraped into mounds for ease in shovel or crane loading of hauling units. Maximum depth of burrow excavation will be depth of thawed or active layer (18″ to 24″). Available only during summer season.



Runway failure due to melting of ice wedge of soil polygon, drainage is not the answer as it accelerates the ice melting.

Eskers—identified by characteristic long snake-like shape. May be 20′ to 50′ wide at the top and 100′ to 150′ wide at the base. Extend for miles, superimposed on rock, muskeg, glacial till and other soils. Contain granular materials excellent for construction. Air strips easily constructed by simply spreading material in an esker. Available all year.

Fans and Deltas—identified by fan shape and diverging stream channels. Contain deposits of sand and gravels. Materials sorted as to size by stream velocity. Available during summer.

Terraces (sea, lake, river)—identified by flat area and usually abrupt difference in elevation at water edge. Sands and gravels sorted and deposited in layers. The edge nearest the stream is usually dry, the inland becomes saturated by run off and develops saturated perma-frost. Installations therefore should be located where vertical drainage is still possible. Available all year.

Salus slopes—identified by cliffs of rock with slopes of weathered debris. Cliffs cut by the sea or glacier action have mechanically weathered making this talus or skree. Requires heavy equipment for loading and hauling. Available all year.

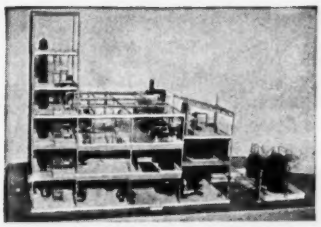
Marginal Moraine — identified by ridge parallel to movement of glacier. Often the only avenue to the upland except on the glacier itself although steep and rough. Materials found are not sorted and not easily worked. Available summer only.

Glacial outwash—identified by fans in moraine areas. (see fans and deltas) sorted granular materials. Available in the summer.

In the discussion thus far, it is hoped that an appreciation of the difficulties of proper selection of locations for transportation, living, or working facilities has been encouraged. Perma-frost indicates its presence in many ways. Engineering decisions in the Arctic should be accomplished with the idea that a thorough knowledge and recognition of perma-frost will make the job easier. The main points to remember are; to become familiar with the manifestations of perma-frost; to build up rather than to dig down; to insulate; to be particularly careful of drainage, and to recognize the advantages of re-location, rather than attempt impossible maintenance.

THE DU PONT DIGEST

FOR STUDENTS OF SCIENCE AND ENGINEERING



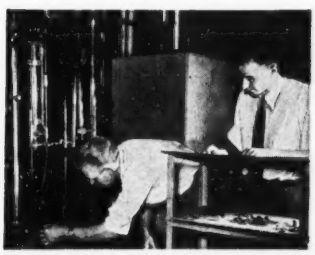
Scale model *of a part of the Du Pont adiponitrile plant at Niagara Falls. Here furfural, an agricultural by-product, is converted into a chemical intermediate for making nylon.*

yarn from corncobs!

A DU PONT PROCESS CONVERTS FURFURAL INTO A CHEMICAL FOR MAKING NYLON

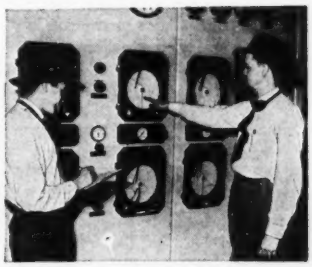
One of the fascinating things about nylon is the unlikely sounding raw materials that go into it. Popularly, nylon is said to be made from coal, air and water. This is because originally, in developing its chemical intermediates, chemists used benzene (from coal), ammonia (from air and water), and oxygen (from air).

But Du Pont is always looking for new ways of doing things. After the discovery of nylon in 1934, research men immediately began looking for alternative ways of making the two main intermediates—adipic acid and hexamethylenediamine. In 1935, when nylon was still in the laboratory stage and three years before its commercial debut, they started work on the possibility of using furfural in the process.



A. G. Sveinbjornsson, *Ph.D., Organic Chemistry, University of Kansas, 1948, and H. B. Copelin, M. S., Organic Chemistry, Cornell, 1941, studying new furfural derivatives.*

Furfural has been used in the chemical industry for 25 years, but it is little known to the layman. A tan-colored liquid with a faint bitter-almond odor, it is made from a wide variety of agricultural by-products. Among these are corncobs and hulls of cottonseed, oats, rice—all available in practically unlimited quantities from America's farms.



C. R. Dewey, *B. S. Chem., Niagara University, 1941, and J. M. Estes, B.S. Ch.E., University of Missouri, 1937, engaged in production of adiponitrile at the Du Pont Electrochemicals plant in Niagara Falls, New York.*

14 Years of Research and Development

It seems a far cry from corncobs to nylon, and it was. The development from the first small-scale laboratory experiments to the present full-scale plant cost 14 years of time and about five million dollars. But it enabled chemists to produce large quantities of adiponitrile, the compound from which hexamethylenediamine is made, by an economical process which uses natural materials that are in continuous supply.

In the new process, furfural is converted by a series of steps to 1,4-dichlorobutane. The next step explains in part why Du Pont undertook the project in the first place. As producers of cyanides, they had sodium cyanide available for converting the 1,4-dichlorobutane into adiponitrile.

The final product, hexamethylenediamine, is then reacted with adipic acid to make nylon "salt." Still more processing and the salt becomes yarn, and the nylon flake used by the plastics industry.

Opportunities at Du Pont in many scientific fields

This is an excellent example of the interesting work in industrial organic chemistry carried on at Du Pont. It required the technical knowledge and skill of highly trained research and development men, including organic and physical chemists; chemical, mechanical, civil and electrical engineers, and others.

Only a large company with ample resources in men and money could afford to engage in research of such magnitude. To the young college graduate, Du Pont offers the broadest of opportunities in many scientific fields, along with the advantages of working directly with a small group of associates.

Keynote of Du Pont personnel policy is promotion from within on a competitive merit basis. A conscientious effort is made not only to choose college-trained people of promise, but to develop each individual as rapidly as possible.

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Stainless Steel

(*Continued from page 26*)

ing of *all* equipment. Stainless steel withstands constant cleaning and its dense, smooth surface minimizes labor and expense of cleaning. Some cities require the use of stainless steel for backbars, dish washing machines and other restaurant service and cleaning equipment. In the appliance field, approximately 14,000 net tons of stainless went into refrigerators in the first ten months of 1948.

The chemical, petroleum and processing industries make heavy use of stainless steel for tanks, reaction kettles, stills, piping, tubing, valves, and the like. In the paper industry, digesters (for both sulfate and sulfite processes), beaters, doctor blades, stock handling equipment such as chests, screens, disintegrating machines, liquor evaporators and other equipment are made of stainless steel.

New uses are constantly being found for stainless steels. These new uses develop primarily in industries which have already recognized the advantages of stainless steel. The greatest potential, in the opinion of many, for large expansion of the stainless steel market is in the construction industry. The year 1948 found considerable use of stainless steel for store fronts, trim, office building lobbies, mullions, roof drainage equipment, and insect screen. It saw the construction of the first office building with exterior walls of stainless steel. Other buildings of the same type are now being designed and this one development will eventually be a large factor in the stainless steel business. Reduced maintenance cost makes stainless particularly attractive to building owners.

The stainless steel industry in the United States has shown steady growth over its entire history. The rate of its growth in the immediate future will be affected by the speed with which the producers develop new markets for use of the material and further exploit the present ones. There is every reason to expect a continuance of this steady progress.

Out of Phase

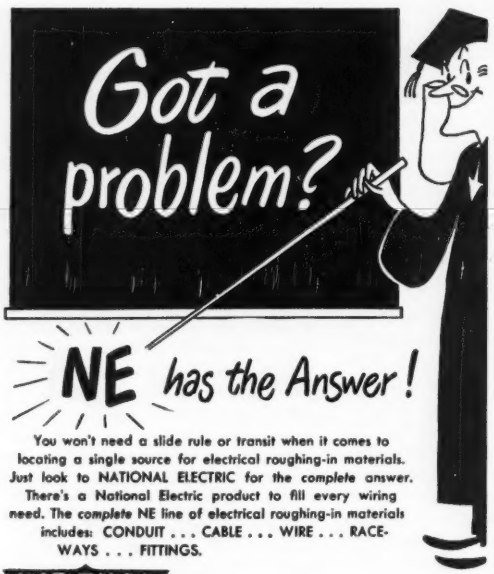
(*Continued from page 25*)

no one admitted to the stacks except employees and holders of stack passes."

"Don't you let that stop you, engineer, no one else does. . ."

And so it was, after only eight hours of attempting to draw a copy of my book, *The Sex Life of the Cathode Follower* by calling for it at the desk that I entered the stacks of Cornell's Main Library. Little did I know what lay in store, or better yet, in stack for me. Oh, the horror of it all . . .

Will lean and gangling Prof. Verbfliesch lean too far or gangle once too often? Does Vladmir Sitzfliesch, boy engineer, illiterate hero of the College of Engineering, find his book? Will the American Legion run out of beer? What does Sitzfliesch meet in the stacks? Next month, in your Cornell Engineer, these questions and many others concerning the future of the world will be answered.



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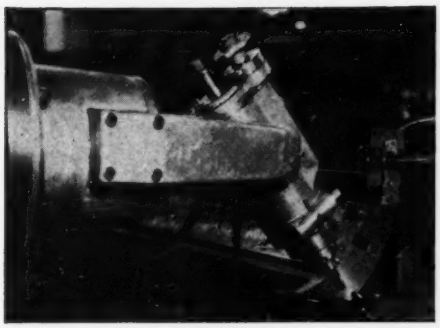
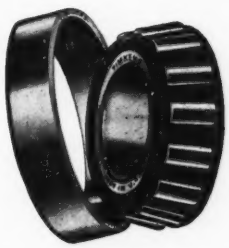
Timken bearings keep the shafts rigid and accurate under heavy radial, thrust and combination loads, eliminate deflection and end-play, reduce wear on moving parts.





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Production Sense

(*Continued from page 12*)

forecast sales on a weekly basis, and modification in the production rate can be made to conform with actual sales. It is not wise, however, to allow production to fluctuate to the extent that sales do. Rather, a long-range understanding of the market will lead to the conclusion that over a long enough period certain more reliable trends may be observed than merely the daily sales reports.

Further use may be made of the control board to check actual production with planned production, and actual shipments with scheduled shipments, so that the inventory is not depleted excessively, nor, on the other hand, is it allowed to increase to the extent that it cannot be liquidated in the forseeable future.

We briefly mentioned three-dimensional floor plans as a technique in developing an organized production floor. The important fact to be kept in mind when applying this technique is motion economy. The principles of motion study apply equally as well to the layout of the production floor as to the motions of the individual worker. Intelligent use of material-handling equipment is an important factor in motion economy. For example, distance between work stations must be kept at a minimum. Work stations must be located so that electric trucks need not return the full length of the production floor without a load. When considering the various methods of handling work, it is often well to remember the possibility of not handling it at all. An eye toward achieving such an ideal condition is a good approach to the problem of laying out the production floor.

Expenditures have been made for machine tools, dies, and fixtures. How well have they performed their jobs? The company interested in maintaining a reputation for a high quality product in a competitive market does not leave this question to chance. A quality control department is charged with the responsibility of developing standards and specifications which must be met by actual test. Dimensional tolerances must be kept. Strength tests, durability tests, and operation tests, all come under the heading of quality control.

Old method of handling finished motors involved individual loading.

Here again a balance must be reached between the cost of testing and testing requirements. Do we design and build special gauges, which speed up checking operations, or will standard gauges suit our purposes? The work of every tool must be checked. It is an expensive matter to design special gauges. While they do have the advantage of combining inspection operations, and suiting the gauge to the job, rather than suiting the job to the gauge, they must justify their existence by careful comparison with standard methods.

In the last analysis, the testing ground of a production plan is its actual operation. The plan must be sufficiently flexible to withstand modification in the face of new experience. Changes are continuously being made. No idea is sacred, nor for that matter is the plan itself, nor is the line of attack suggested here intended as the last word in setting up a production plan. It is only one of numerous possibilities that may suggest themselves to the imaginative and open-minded manufacturing engineer.

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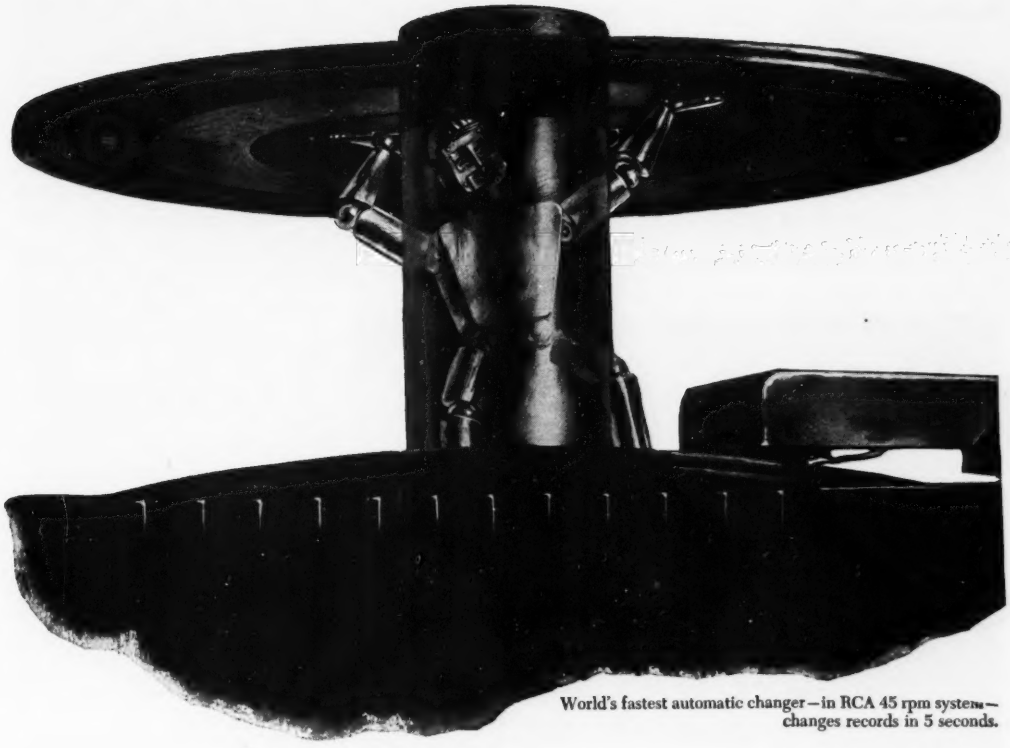

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Planetarium

(*Continued from page* 14)

the ends of the "dumbbell." A consideration of the motions of the bodies of the solar system, all moving with different velocities in different orbits, shows that the simple arrangements used to move the field of fixed stars do not apply to them. The Sun, the Moon, Mercury, Venus, Mars, Jupiter, and Saturn are actually oriented 180 degrees out of phase and their projectors reversed, for mechanical reasons.

Because of the struts which form the framework in which this equipment is located, there are two projectors for each body in the solar system, so that one projector is always unobstructed. In addition to the two projectors providing the image of the Sun, there are five more in that section of the frame-

The Zeiss Planetarium Instrument at work. The "eyelids" on the projectors can be seen, along with the array of motors and special projectors about the center of the assembly.

—Courtesy Franklin Institute

are shown; they all move in a plane perpendicular to the 2-2, or precession, axis and passing through the center of the dumbbell.

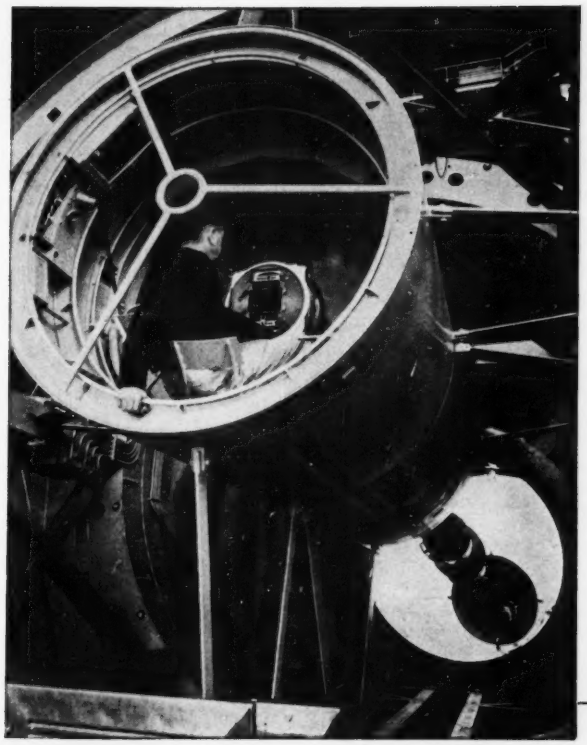
The general method of locating images of the members of the solar system is to set up a mechanical model in which a point representing the earth and one representing the body to be projected have the proper relative motion. The two points are connected by a bar which can slide to allow for the variations in distance between the two bodies as they move at different speeds in their respective orbits, but always forms the line between them. A projector on this bar, aimed from the earth point to the point representing the body to be projected, will produce a properly located image on the inside of the dome, if the arrangement is correctly oriented in the first place. The mechanisms for the Moon, Mercury, and Venus work to provide other luminous effects which the sun causes. Two provide a glow or "aureole" around the sun itself, one provides the "zodiacal light" which extends some distance to either side of the Sun, and two project the "gegenschein"—German for "counterglow" —which appears as a faint area of brightness in the portion of the sky opposite the Sun. The designers of the instrument took great pains to make its projected sky complete in every detail.

The Time Element

A wide variety of motions are available to the planetarium lecturer, who is thus allowed great flexibility in making his demonstration effective and interesting. The most common arrangement is to have all the motions operating together, with the planetary and precessional motions driven by a system of gears and differentials. In this way the apparent motion of the real sky is exactly duplicated, even to the precessional cycle, which is completed by the earth every 25,800 years. This is the result of the slow turning of the earth's axis of rotation, just as a top, whose axis is tilted, turns slowly. A day can be made to pass in eight different periods, ranging from 10 minutes, 30 seconds down to 48 seconds. In addition, the planetary and precessional motions can be operated independently, so that a year may be made to pass in almost any desired period from 5.15 seconds to 3 minutes, 3 seconds.

An interesting consequence of this variety and rapidity of motion, and of the accuracy of the instrument, is that the planetarium may be used to "travel" in time as far as the sky is concerned. It is possible to move thousands of years backward or forward in time, and see the sky just as it was or will be. In the Fels Planetarium of the Franklin Institute in Philadelphia, the instrument is used during the Christmas season to show how, at the time of the birth of Christ, several planets appeared very close together in the sky; some believe that they were seen as the Star of Bethlehem.

A description of the planetarium instrument is not complete without a paragraph concerning the chamber which houses it. The room is circular and domed, 66 feet in diameter. The bottom of the inverted hemisphere which forms the dome is at the height of the center of the "dumbbell" portion of the instrument and forms the horizon. In the Fels Planetarium the dome is of stainless steel, painted white and perforated to absorb undesirable echoes. The plates have been cut away at the horizon so that the missing areas are in the shape of the Philadelphia skyline as seen from the Franklin Institute. A titled black screen is placed behind, so that no star images appear below the skyline. The lecturer stands at a station near the wall of the room, from which he controls the motions of the instrument and operates various special projectors for meridians, constellations, and other effects.



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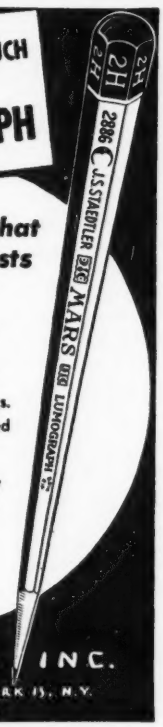

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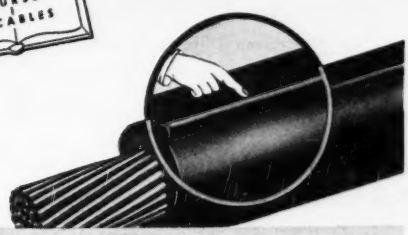
STAEDTLER SINCE 1662

LOOK FOR THIS RIDGE



AND YOU FIND A REASON

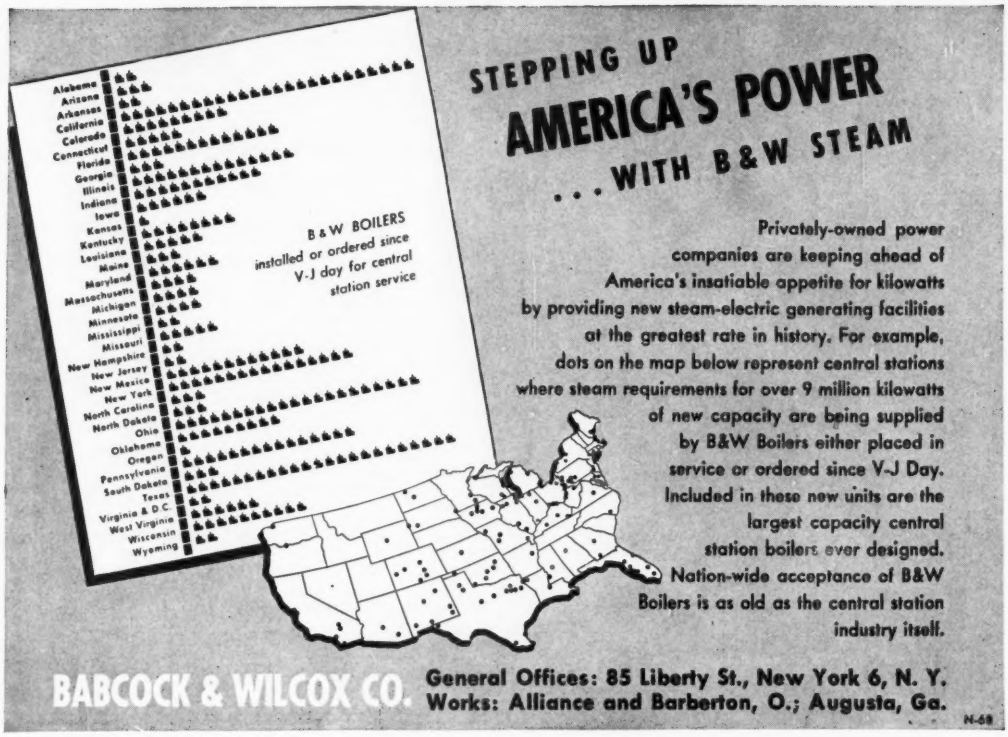
● There is more than mere identification value in the ridge you see on Okonite wires and cables. The ridge is proof that the insulation has been folded around the conductor by the well-known Okonite strip insulating process. This method permits inspection at all times during the application operation. It assures the perfect centering of conductors so important to the avoidance of electrical failures.

The ridge is a permanent mark of an Okonite cable. It is still prominent after the final vulcanization in a metal mold that insures equal transfer of the heat throughout every portion of the insulation. The Okonite Company, Passaic, New Jersey.

6065

OKONITE SINCE 1878

insulated wires and cables



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Prominent Engineers

Bob Schutt

(*Continued from page* 17)

Bob comes from Grand Island, New York, where he graduated from Riverside High School in 1944. While in high school, Bob won letters in football, baseball, swimming and track and won the position of valedictorian of his class. For the next two years he went to school in Deep Springs, California and then took a hitch in the Navy as a radio technician and instructor. It was this experience plus his interest in ham radio that primarily caused Bob's double registration in EE.

Bob has actively combined his academic work with his outside interests, letting neither suffer unduly at the expense of the other. He is now in his fourth year with the men's glee club of which he has been publicity manager and business manager. At present, Bob is also a member of Tau Beta Pi and is probably one of the few people to hold joint memberships in Eta Kappa Nu and Pi Tau Sigma.

Bob's hobbies, which include photography, ham radio and sailing, take up what time he has left after his work in school and around campus and in his fraternity, Kappa Sigma, is done.

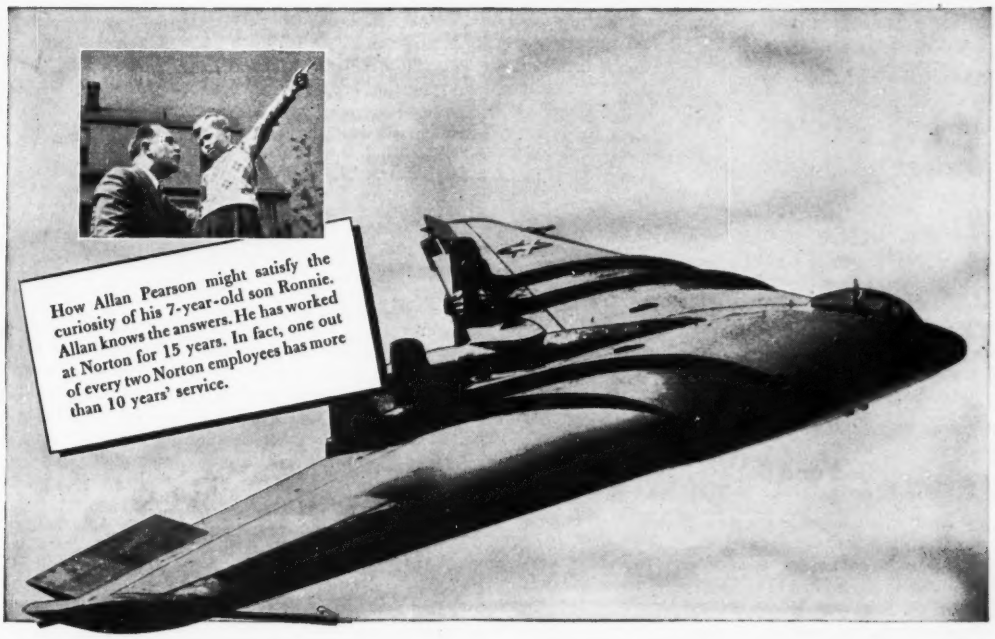
During the summer, Bob splits his time between working for his Dad's trucking company, attending transportation conventions and working on a farm. When he gains that second degree, he plans either to continue working with his father or else to start a modern farm.

Neal FitzSimons

(*Continued from page* 17)

In addition to these positions on the engineering campus, Neal received his commission from Advanced ROTC last summer, and has been head usher at Sage Chapel for the past two years.

When he graduates this June, Neal hopes to enter graduate school for his Master's Degree in Civil Engineering. At present, he thinks he would like to work in the comparatively new field of geophysics, with the hope of contributing something to the work which has already been done. Considering the contributions he has already made to Cornell life, it will not be surprising if he does.


How Allan Pearson might satisfy the curiosity of his 7-year-old son Ronnie. Allan knows the answers. He has worked at Norton for 15 years. In fact, one out of every two Norton employees has more than 10 years' service.

GEE, DAD, WHAT MAKES IT GO SO FAST?

"It's power that does it, son. Power from its new jet engines. Engines built with parts made from today's strongest, toughest metals . . . parts that fit within one ten-thousandth of an inch."

"Those tough parts are shaped by tougher tools. Tools sharpened by Norton grinding wheels made from our 32 Alundum abrasive, the fastest, coolest cutting abrasive ever made... and our famous Diamond Wheels, a Norton first in 1930.

"Then those engine parts are shaped smooth and true by Norton grinding wheels. And those parts fit each other just right. That's because of the sure finishing touch of Norton grinding wheels and machines.

"And when that giant lands, it lands safely because Norton engineering created a special grinding machine that helps make the landing gears' odd-shaped parts fit true and tight and strong."

"Yes, Ronnie, Norton helps make airplanes better. Other products, too. In fact, there's hardly anything man makes that doesn't get a lift from Norton somewhere along the line. That's why I'm proud of my job of making better products to make other products better."

NORTON

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College Societies

(*Continued from page* 23)

Metallurgical Society

Originally formed last year as an organization only for students registered in metallurgical engineering, the Cornell Metallurgical Society has expanded for this year and is open to all students on campus interested in the field.

Last year's officers will continue through for this year. They are Nicholas Sheptak, president; Hal Moon, vice-president and program chairman; Paul Widener, secretary; Robert Folkman, treasurer.

Rod and Bob

This social honorary society is the oldest in the School of Civil Engineering. The general aim of the society is the promotion of good fellowship among members and to make their last years of college life more enjoyable. Also, contact with the various members after graduation is maintained to relay information on jobs and opportunities in the engineering field. Various projects are supported to maintain interest in the Civil Engineering School. A student must be a Junior to become eligible for membership and must be elected by a unanimous vote of the active members. Academic standing and personality are prime qualifying factors.

Pyramid

The Pyramid Society, founded sixty years ago as a cooperative is designed to promote spirit in the School of Civil Engineering and to discuss matters of interest to civil engineers. The society consists of thirty students plus faculty members. Students are selected each year from those in their last half of their undergraduate careers.

The officers for the year are Mark Shriver, president; Frank Senior, vice-president; Dave Morgan, secretary-treasurer.

American Society Of Civil Engineers

This society attempts to create interest among students in Civil Engineering for holding field trips and presenting movies and lectures for students. The society is planning to expand by communicating with other engineering schools. Also the Northeast conference of Civil Engineers will be held at Union College; and a field trip is being planned to Syracuse. Any student registered in the C.E. school is eligible for membership, and freshmen are particularly invited to join. Elections for the year are to be held early this term.

(*Concluded on page* 40)

MACWHYTE WIRE ROPE

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for
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Here is something brand new for kid sister or brother. Cardigan award type sweaters in Cornell red with block 'C' in white. Sizes 2 to 12, 100% wool $4.95

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JUVENILE FROSH CAPS

Another new one — Cornell red with numerals 19-C-? $1.00

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And don't forget the juvenile T-Shirts. We have all sizes at $1.00

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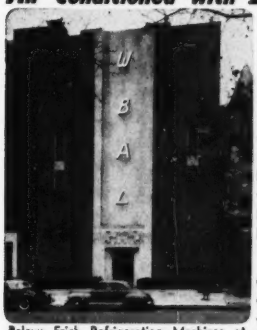
THE CORNELL CO-OP

Barnes Hall On The Campus

Air Conditioned with Frick Refrigeration



The new building of Maryland's largest broadcasting and television station, at Baltimore, is air conditioned throughout with three Frick compressors, each having four cylinders, as shown below. This fine installation won the 1948 Building Trades Award for the Paul J. Vincent Co., Baltimore Distributors for Frick Refrigerating, Ice-making and Air Conditioning Equipment.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

Below: Frick Refrigerating Machines at Radio Station WBAL

DIAGRAMMATIC CROSS-SECTION VIEW OF A

LUFKIN Chrome Clad Steel Tape

This cross section view gives you the "inside story" of the most outstanding development in steel tapes in years. (1) Hardened steel tape—tough—flexible—kink-resistant. (2) Rust resistant coating. (3) Multiple coats of electroplating. (4) Hard, smooth, non-glare chrome plating. Will not crack, chip or peel. (5) Jet black markings—easy to read in any light—bonded to steel base—sunk below chrome surface protecting them against wear.

Ask your distributor for them or write for complete details on Lufkin Chrome Clad "Super Hi-Way," "Pioneer," and "Michigan" Chain Tapes.

THE LUFKIN RULE CO.
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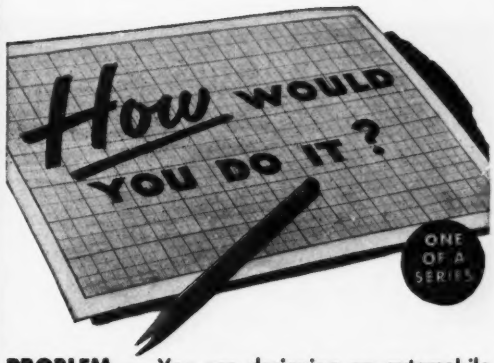
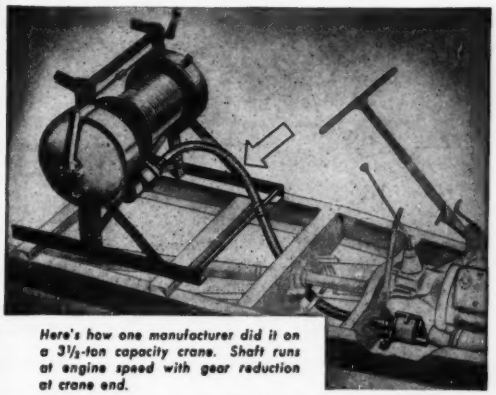
PRECISION TOOLS—TAPES—RULES

EASY TO READ MARKINGS THAT ARE DURABLE



PROBLEM — You are designing an automobile service car with a crane on the back end. You are going to take power from the transmission to drive the crane drum. How would you do it?

THE SIMPLE SOLUTION — Use an S.S.White power drive flexible shaft. Connect one end to a take-off on the transmission and the other end to the clutch which operates the crane drum—simple, easy to install, good for positive, dependable operation.



Here's how one manufacturer did it on a 3½-ton capacity crane. Shaft runs at engine speed with gear reduction at crane end.

This is just one of hundreds of remote control and power drive problems to which S.S.White flexible shafts provide a simple answer. Engineers will find it helpful to be familiar with the range and scope of these useful "Metal Muscles"* for mechanical bodies.

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WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours for the asking. Write today.

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Which of these dredging jobs do you have?

DO YOU WANT TO...

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2. Deepen lakes or channels?
3. Clean out reservoirs?
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5. Fill in undesirable lowlands?
6. Do any unusual dredging job?

Whatever the job, Morris Engineers study and analyze your needs. They recommend the exactly right dredge. They design, build and install it all ready for operation.

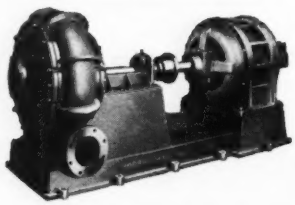
Should your dredging jobs occur in different cities or states, Morris will build a portable dredge. Quickly and easily dismantled, you can move it from place to place at minimum expense.

All dredges are complete with electric motors, Diesel or gasoline engines . . . permanent or portable hull . . . rigging, hoist, spuds, ladder . . . ladder head and any of various cutters . . . piping and fittings. Morris will also furnish an operator, if necessary, for an initial period of time until your own operator learns how to operate and maintain the dredge.

The Midwest Dredging Company Dredge—one of the newest Morris installations.

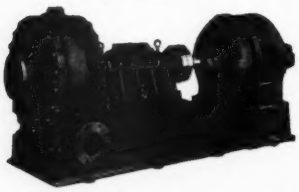
ORDER NOW! If you need your dredge in the Spring, now is the time to order it. Write for free bulletins today!

FOR MORE THAN 87 YEARS, Morris has built dredges and dredging machinery for almost every requirement.



Sand, Gravel and Dredging Pumps

Built in standard, medium duty and extra heavy types, in sizes from 4" to 48", with electric motor, steam, Diesel or gasoline engine drive.



Lined Material-Handling Pumps

Specially built for handling highly abrasive materials. Does not have sectional liners or bolt heads to wear out.

MORRIS MACHINE WORKS
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MORRIS *Centrifugal Pumps*

College Societies

(*Continued from page* 38)

American Institute of Chemical Engineers

The American Institute of Chemical Engineering was founded for the purpose of correlating and disseminating information on topics related to chemical engineering. The Cornell Chapter was founded in 1937. The society has monthly meetings, part of which time is devoted to a lecture by an authority on some phase of chemical engineering. All those in or above their sophomore year in chemical engineering are eligible.

Engineering Council

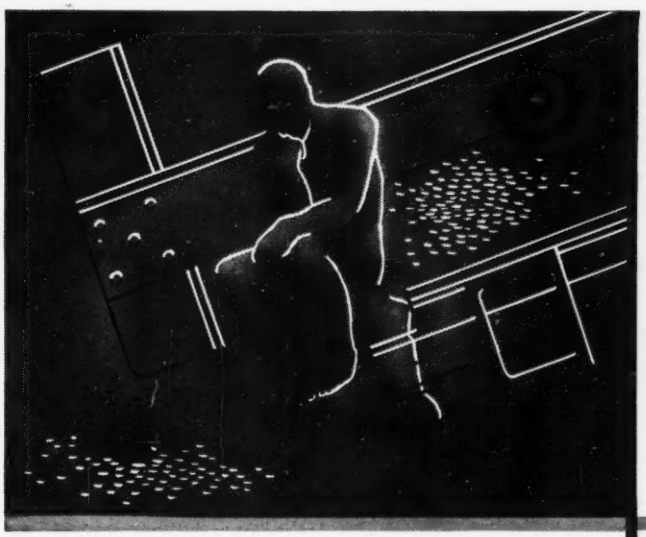
This organization, representing the student body of the engineering college on campus, was organized last year and has already gone far in fulfilling its purpose. It organized and sponsored a successful revival of Engineers' Day last spring as an annual affair and arranged and presented the engineers' dance this fall.

The Council periodically publishes the *Engineering Council Notes,* containing announcements of interest to engineers, and a list of forthcoming meetings and lectures sponsored by organizations in the College.

Pros-Ops

Pros-Ops was founded at Cornell University during 1947 as an honorary society for students in chemical engineering. To be eligible for membership, a student must be in good standing scholastically and must either be participating in athletics or have successfully completed a competition. Its purpose is to promote good fellowship in the Chemical Engineering School, and to foster extra-curricular activities.

Its officers are Joe Calby, president; Roger Chamberlain, vice-president; Marjorie Leigh, secretary-treasurer.



Thinking of improving

"Improving" any machine really means increasing its productive capacity. That means tinkering with speeds and weights and strength—ending up with alloy steels.

Which alloy steel?—the one that meets physical requirements at the lowest cost. Molybdenum steels fill that bill. Good hardenability, plus freedom from temper brittleness, plus reasonable price enable them to do it.

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PUZZLE OF THE MONTH

A certain farmer has $100 to spend on improvements for his farm. After much deliberation he decided he would like to buy 100 head of livestock. The prices for stock available were as follows:

Chickens at 50 cents
Pigs at $5.00, and
Cows at $10.00

How can be buy one hundred head of stock for $100?

▼

Answer to last month's puzzle: $14.32

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STRESS *and* STRAIN...

A colored preacher was hearing a confession. In the middle of it he stopped the young sinner, saying, "Young man, you ain't confessing, you is bragging."

* * *

Ed: "Have you got a picture of yourself?"

Roommate: "Yeh."

Ed: "Then let me use the mirror. I gotta shave."

* * *

Prof: (to a noisy class) "Order, please!"

Student: (in rear of room) "I'll have a beer."

* * *

A little coed came into the office of a psychiatrist.

"I was wondering, she announced timidly, "if you could split my personality for me."

The doctor looked puzzled. "Split your personality? Why would you want that done?"

Tears tumbled down her miserable face. "Oh doctor," she wailed, "I'm so lonesome."

* * *

She: "Isn't it funny that the length of a man's arm is equal to the circumference of a girl's waist?"

Liberal Arts Student: "Let's get a string and find out."

* * *

The tired CE arrived home. The cook had left that morning without notice. His bridge had just fallen down, and to climax the day, he found a farewell note from his wife. He knew a shot would end it all. So he opened a bottle and took one.

BLACK KNITS AND WHITE BUCKS AT THE SPORT SHOP!
"DID YA GET THE WIDOW?"
"WHERE'S YA FROSH CAP?"
PLEDGE OUR HOUSE FRED!
BOUGHT YA CLARA DICKSON PHONE BOOK YET?
KALTBAUM '49

GREETINGS, FREDDIE FROSH!

Prof: "Were you copying his paper?"

Student: "No, I was just looking to see if he had mine right."

* * *

A wise man is like a straight pin: his head keeps him from going too far.

* * *

Question in an EE class: Who was the cleverest inventor?

Answer: Edison. He invented the phonograph and the radio so people could stay up all night burning his electric lights.

"Well, Sam, I see you're back for fighting with your wife. Liquor again?"

"No sah, Jedge, she licked me dis time."

* * *

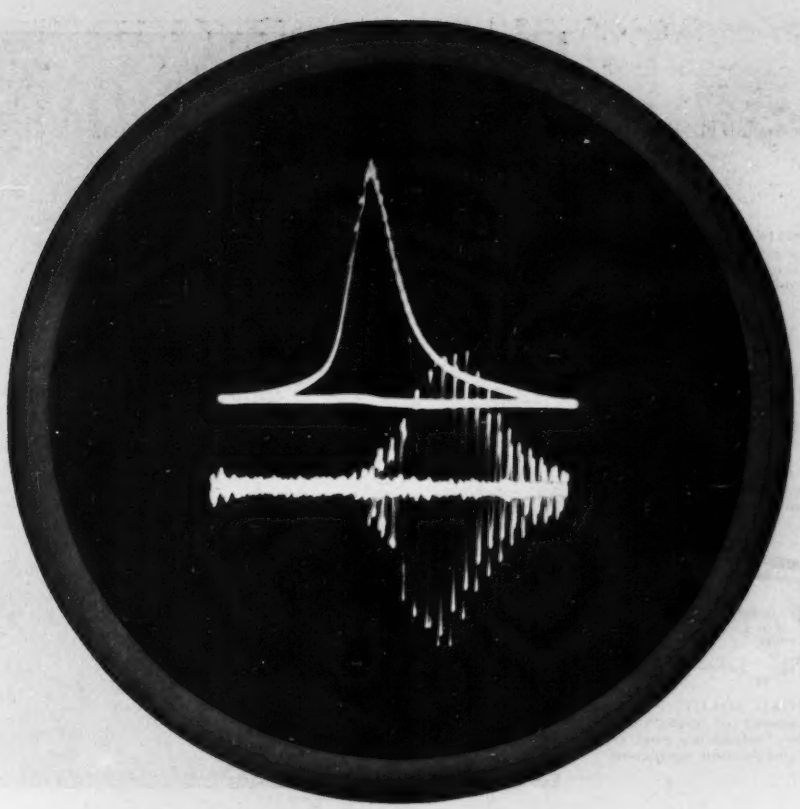
Prof: "When this room settles down, I'll begin to lecture."

Student: "Why don't you go home and sleep it off?

* * *

Professor, "Who was Talleyrand?"

Senior: "A fan dancer, and cut out the baby talk."



This is a picture of "PING"

It's a picture that gives automotive engineers clear-cut facts on performance—a picture that suggests how photography with its ability to record, its accuracy and its speed, can play important roles in all modern business and industry.

No, this is not the "doodling" of a man on the telephone. Far from it. It's the photographic record of an oscilloscope trace that shows, and times, detonation in a "knocking" engine. It all happens in a few hundred-thousandths of a second—yet photography gets it clearly and accurately as nothing else can.

Oscillograph recording is but one of countless functional uses of photography in bettering products and improving manufacturing methods. High speed "stills" can freeze fast action at just the crucial moment—and the design or operation of a part can be adjusted to best advantage.

And high speed movies can expand a second of action into several minutes so that fast motion can be slowed down for observation—and products be made more dependable, more durable.

Such uses of photography—and many more—can help you improve your product, your tools, your production methods. For every day, functional photography is proving a valuable and important adjunct in more and more modern enterprises.

Eastman Kodak Company, Rochester 4, N. Y.

Functional Photography

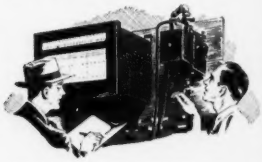
. . . is advancing business and industrial technics

Kodak

TRADE-MARK

THE MAIN JOB *of one entire laboratory at General Electric is to keep guesswork out of G-E products.*

ITS STAFF *specializes in giving help on tough measurement problems.*



TYPICAL SOLUTION *was development of first "turbidimeter," advancing work on water-purification equipment.*

1000 Specialists tell us "When you can measure..."

Lord Kelvin, writing in 1883, summed up once and for all the importance of measurement.

"When you can measure what you are speaking about," he said, "and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind."

The need for detailed and accurate "numbers" is as great today as it ever was. Recently, for example, General Electric engineers working on water-purification equipment were hindered by the lack of any accurate way to measure water's turbidity. Another group needed data on the vibrations in their equipment.

But at General Electric any group up against tough measurement problems does not have to be stymied for long. It can "appeal" its case, can seek the aid of men who make a specialty of measurement and allied problems—the more than 1000 staff members of the G-E General Engineering and Consulting Laboratory. GE & C serves the entire company, and is also frequently called on by other industries and government agencies.

It solved the two problems above by developing the first "turbidimeter" and a "recording vibrometer" now finding applications throughout industry—two out of thousands of similar problems handled by the laboratory each year.

The work of GE & C illustrates again how General Electric backs up research and creative thinking, implements new projects with the best available facilities, and so remains in the forefront of scientific and engineering development.

You can put your confidence in—

GENERAL ELECTRIC